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ANNUAL MEETING PAPERS IN THIS ISSUE

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THE MEASUREMENT OF THREAD GAGES

Description of the Instruments and Methods Used by the Bureau of Standards for the Measurement of Plug and Ring Thread Gages

By H. L. VAN KEUREN,[1] WASHINGTON, D. C.

MANY of the members of this Society will recall that through the Gage Committee it was recommended that there be a central place for the certification of all master gages. The Committee further recommended that inasmuch as Congress has provided the Bureau of Standards with a fund for the certification of gages, and, furthermore, inasmuch as the Bureau of Standards was organized and prepared to handle promptly the test of all master gages, the Bureau be designated as the official place for the certification and test of gages for the various departments of the Federal Government. It is of particular interest, therefore, that the Society should know the developments that have taken place along the lines recommended, and in this connection the present paper is prepared.

MEASUREMENT OF PLUG THREAD GAGES

There are five distinct operations in the measurement of a plug thread gage, namely:

1 The measurement of pitch or lead
2 The measurement of form and angle of thread
3 The measurement of core diameter
4 The measurement of full diameter
5 The measurement of effective diameter.

Measurement of Pitch

After trying various commercial machines for measuring pitch, the machine adopted for this purpose by the Bureau of Standards was of a design similar to that of the National Physical Laboratory of Great Britain. This machine, Fig. 1, is capable of making direct measurements of pitch, and, furthermore, is not limited to any one thread interval, but determinations of the lead between any two threads may be measured. About twelve of these machines have been constructed and are in use at the various branch laboratories of the Bureau of Standards. There are incorporated in these machines special micrometer screws designed and constructed by Dr. J. A. Anderson, who is associated with Mount Wilson Solar Observatory, Pasadena, Cal. These micrometer screws are provided with aluminum heads which are graduated directly to 0.0001 in. and the screws have straight-line calibration curves to within 0.00002 in. They are therefore very well suited for the purpose for which they are used.

The operation of the Bureau of Standards pitch-measuring machine may best be explained by referring to Fig. 1 as follows: A ball-pointed stylus A rests in the thread to be measured. This is carried at the end of a floating arm B which at the other end carries a lens C. The arm B is supported by a flexible, flat steel spring D and the movable support upon which the spring is carried is so adjusted that the spring D exerts a slight pressure on the floating arm B which tends to cause the stylus A to rest firmly against the flanks of the thread. When the stylus is resting evenly on both flanks of the thread the lens C is directly beneath the lamp E and the image of the straight filament in the lamp E is projected by the lens C downward to a prism H, thence under the machine to the prism I, from where it is reflected to the screen S. When the image of the filament coincides with a reference line on the screen S, the reading of the micrometer M is recorded.

The turning of the micrometer head M causes the carriage supporting the stylus, lens, lamp, prisms and screen to move with reference to the thread, which remains stationary. Upon moving the micrometer head an amount corresponding to one thread interval the stylus comes to a position in the next thread similar to the position in the preceding thread and the micrometer head is adjusted until the image of the filament coincides with the index line as before. The micrometer reading is again recorded. The difference between the two micrometer readings indicates directly the pitch interval passed over.

Similarly each thread interval may be measured and the pitch along the entire threaded portion may be investigated. The stylus, lens, lamp, and screen form merely a sensitive optical indicator which serves to enable the pitch to be measured with a micrometer head. It is interesting to note that during the course of movement of the stylus from one

ANNUAL MEETING PAPERS

The thirty-ninth Annual Meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, December 3 to 6.

The practice of previous years of having a topic of broad general interest for the leading session of the meeting will be adhered to by assigning one day for the discussion of subjects relating to Human Relations in Engineering and Industry.

Papers have been contributed by the Sub-Committees on Textiles, Industrial Buildings, Machine-Shop Practice and Gas Power. There will be a joint session with the American Society of Refrigerating Engineers, and at least two sessions for the presentation of miscellaneous technical papers.

Comprehensive abstracts of the papers to be presented are published in this number of The Journal and will be continued in the December issue. All the Annual Meeting papers appearing in The Journal are also being printed in unabridged pamphlet form for advance distribution, and members of the Society desiring a complete copy of any particular paper, previous to the meeting, may obtain it upon application to the Secretary.

Contributed discussion upon these papers is invited for presentation at the meeting and publication in The Journal and Transactions.

[1] Chief of Gage Section, Bureau of Standards.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

thread to the next, it climbs up over the crest of the thread and down into the next groove. During this movement the image of the lamp filament is no longer confined to the screen but the image is again brought back to the index point when the correct position in the next thread is obtained.

The optical indicating apparatus forms a convenient means of standardizing the micrometer head *M*. When this is done a thread gage is inserted in the machine as if it were to be tested and flat-end standards or size blocks are inserted between the micrometer spindle and ball contact against which it rests, the carriage being kept stationary and the image of

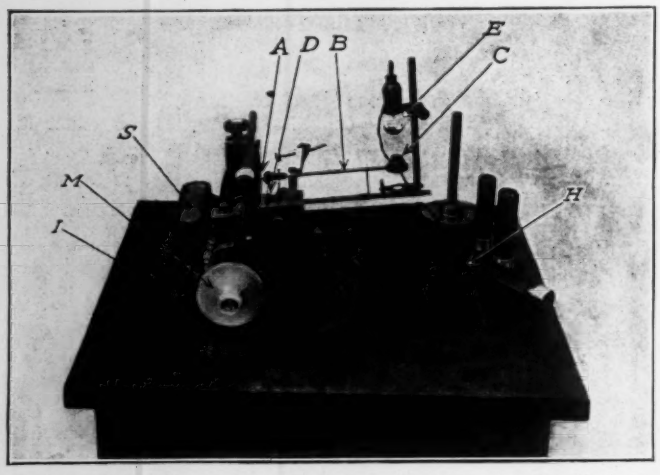

FIG. 1 PITCH-MEASURING MACHINE ADOPTED BY BUREAU OF STANDARDS

the filament brought back to the same point with the stylus in the same thread of the thread gage at each observation.

Questions have been asked as to the result if a thread gage is not concentric with the centers. If any such indication is present the screw can be revolved 180 deg. and again tested, or it may be turned end for end in the centers of the machine. Experiments in which this procedure was taken with a large number of thread gages indicate that the difficulties of this nature are of little importance.

A still more recent development of the National Physical Laboratory is shown in a pitch-measuring machine similar in principle to the one just described, but which makes use of a mechanical indicator permitting the machine to be operated in strong daylight, whereas the optical indicator requires a subdued light or a shade around the ground glass. The micrometer-head arrangement in this machine permits the lead error to be read directly.

MEASUREMENT OF FORM AND ANGLE OF THREAD

In the measurement of thread form or thread angle various methods such as those employing microscopic devices, conical test points, and other forms of angular test pieces used in connection with visual inspection, have been investigated and tried out, but practically all of these devices have been discarded in favor of the projection lantern. A general idea of the arrangement used at the Bureau of Standards for the projection lantern may be obtained from Fig. 2.

The operation of the projection lantern involves the placing of the thread to be examined in a beam of parallel light and, by means of a suitable lens system, the projection of the shadow of the thread on a distant screen. In the apparatus shown in Fig. 2, the light from a 10-ampere arc enclosed in housing *L* is emitted through the condensing lens *A* and directed toward the projecting lenses *B* and *C*. The screw is placed at the focus of the lenses *B* and *C*. The projection is then directed upward by a prism *G* to a mirror (not shown) which is supported about 10 ft. above the prism on the column *K*. The projection is then directed down by the mirror to the top of stage *N* which forms the screen and carries the standard angle *M* used in the examination of the thread form. As it is necessary that the parallel beam of light pass through the thread at the helix angle so that the shadow cast will be a true cross-section of the thread form, the lamp housing which carries the condensing lens *A* is pivoted about a point beneath the lens *B*. This insures that the beam of parallel light emerging from the lens *A* will always be directed at and fill the lens *B*.

Adjustments for Examinatien. The setting up of a thread gage for examination requires but a slight amount of adjustment. The stand *E* is provided with a motion for raising and lowering the thread, a motion for focusing the thread, and another motion for moving it along its axis in order that various portions of the thread may be brought into the center of the screen. The screw to be examined is supported by the spring centers which are carried on the stand *E*. For convenience in making observations it is raised until the center of the beam of light is passing the under side of the thread. The lamp *L* is then turned about the axis of its support until the parallel rays of light emerging from the lens *A* pass through the helix angle which occurs when the fringe pattern which is formed about the image of the screw due to imperfect focus, is symmetrical. The screw is then brought into focus by a slow-motion arrangement.

Measurement of Angle. The examination of the thread angle is conveniently made with a device shown on the table in Fig. 2. With this arrangement the standard angle *M*, known to be 60 deg., is supported by three columns on the revolving stage or screen *N*, which rests on a graduated cir-

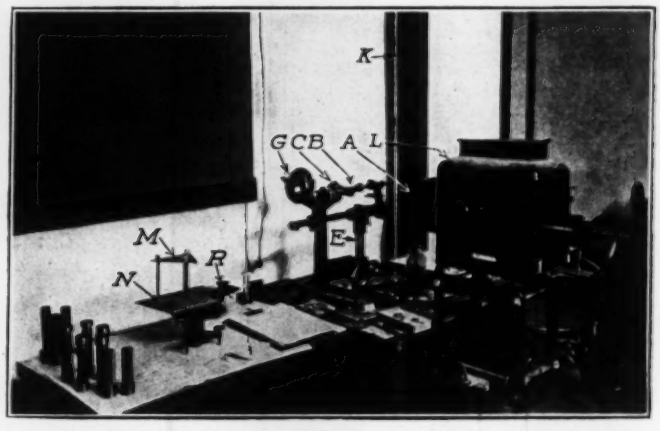

FIG. 2 PROJECTION LANTERN USED AT THE BUREAU OF STANDARDS

cle or protractor head. In the protractor shown in Fig. 1 the graduated circle was obtained from a theodolite. During the examination of the thread angle, the opaque standard angle *M* is adjusted so that its shadow occupies the light space of the projected image which is cast on the surface below at *N*. The standard angle *M* is revolved so that one side exactly matches with the shadow of the thread as cast below and the reading of the graduated head is obtained through a magnifying glass. The gage is then shifted parallel to its axis by means of a slow-motion device on the stand *E* until the image of the other side of the thread approximately coincides with the other side of the standard angle. The standard angle is then revolved by a slow-motion screw operating the graduated circle until it again lines up with the other side of the thread, whereupon a reading of the graduated circle is again obtained.

The difference between the two readings shows directly the error of the included angle of thread if the standard angle *M* represents the correct thread angle.

Further application of the protractor arrangement is in the determination as to whether the thread is symmetrical about a line perpendicular to its axis. This may be verified by revolving the standard angle and matching it with the crest of the thread or by matching a straight edge which is placed perpendicular to a bisector of the standard angle with the crest of the thread.

Accuracy of the Method. It should be specially pointed out that the "shadow protractor" is an exceedingly effective device for the measurement of thread angles, much more so than any protractor, lying directly on the plane of the shadow, could be. This is because the eye is viewing two objects of similar character, namely, two shadows. When adjusting the gage for a reading, the shadows of thread and gage are made to approach and the protractor is angularly adjusted until only a faint, even thread of light remains between the two. Under these circumstances, an inaccuracy of but a few minutes is easily detected. Furthermore, the operation of the protractor is rapid. In case of particularly defective threads, exposures of the projection may be made on any photographic developing paper with an exposure time determined experimentally and a permanent record obtained of the condition of the thread.

Measurement of Core Diameter

The measurement of the core diameter of thread gages is in most cases a simple matter. It is mentioned at this point because the examination of the core diameter is generally included in the operation of investigating the thread angle and thread form while the gage is in the projection lantern previously described. It is the practice in most specifications

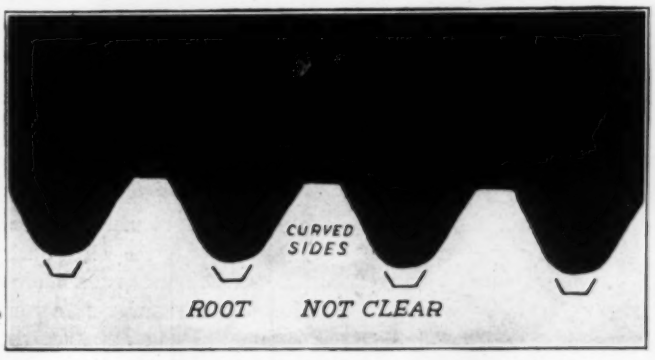

FIG. 3 PROJECTED SHADOW SHOWING THREAD NOT CLEARED SUFFICIENTLY AT ROOT

to call for thread gages cleared or cut below the nominal flat required by the regular United States form at the root of the thread. This is done to facilitate lapping. In order to determine whether or not a gage is properly cleared when examining the projected shadow, it is only necessary to insert a suitable templet corresponding to the pitch of the screw being measured. If the projected shadow of the thread shows that it is clear below the templet form, it is passed as being correct. Fig. 3 shows a thread which has not been cleared sufficiently at the root.

Measurement of Full Diameter

The measurement of the full diameter of plug thread gages is accomplished by the ordinary forms of flat-face micrometers or other suitable end-measuring instruments used in connection with properly authorized standards. These measurements are so simple and familiar to any one making gage inspections that no further comment will be made in this connection.

Measurement of Effective Diameter

Of the various methods which have been proposed for measuring effective diameters of male thread gages, the three-wire method is believed to be the most accurate and satisfactory. This method has been in common use for about 15 years. In measuring screws by the three-wire method, cylinders accurately ground and lapped to size and diameter are used. These wires or cylinders are inserted in the thread two on one side and one on the other. A measurement is then made directly over the tops of the wires by means of an outside micrometer or other suitable measuring device. From this measurement and from the size of the wire the effective diameter of the screw can be computed.

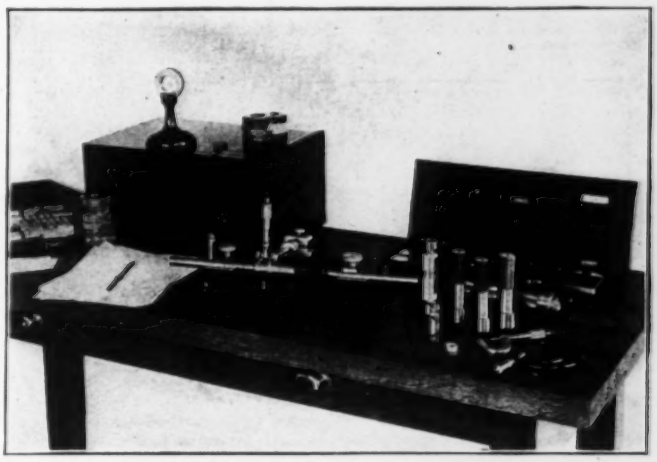

FIG. 4 APPARATUS USED IN MEASURING GAGES BY THE THREE-WIRE METHOD

Choice of Wires

In the choice of wires any size may be selected which will permit the wires to rest on the flanks of the thread and still project above the top of the thread. It is best, however, to choose wires of such a size that they touch the sides of the thread half-way down, or, in other words, at the mid-slope. In this case errors in the included angle of the thread have no effect on the measurement of an effective diameter. Moreover, the time spent in computations is greatly reduced. The best sizes of wire for various threads may be computed from the following approximate formula:

$$G = \frac{P}{2} \sec a$$

where G = diameter of wire, in.
P = pitch in in.
a = ½ included thread angle, deg.

For 60-deg. threads this formula reduces to

$$G = 0.5774 \times P$$

Standardization of Wires

Before the wires can be used to measure effective diameters of threads it is necessary to know accurately their diameters. The wires should be standardized in a way which approximates, as nearly as possible, the conditions under which they are used. In order to accomplish this purpose the wires are standardized with a micrometer caliper by measuring the

wire when placed over a standard reference disk, the diameter of which is accurately known. The object of measuring the wire over a cylinder is to approximate the condition of pressure which is exerted upon the wire when it is placed in the screw thread.

Computation of Effective Diameter

In the computation of the effective diameters of thread gages, if the exact conditions are recognized the formula is quite complicated and the resulting computations are very laborious. The formulæ for computing effective diameters as given in most engineering handbooks involve the use of best-size wire and do not take into account the complications introduced when considering the effects of the helix angle of the

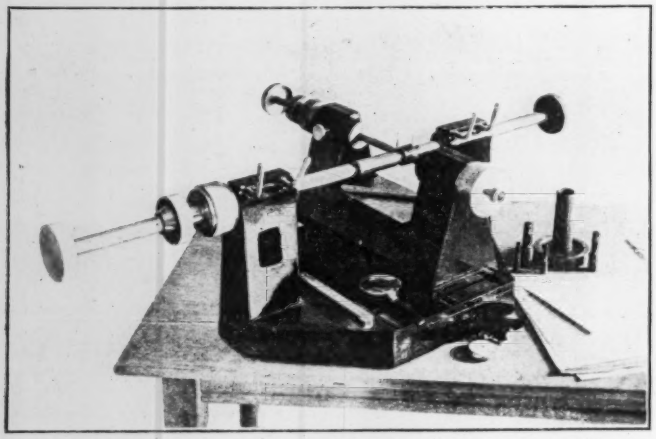

Fig. 5 Apparatus for Making Wire Measurements Using Two Wires

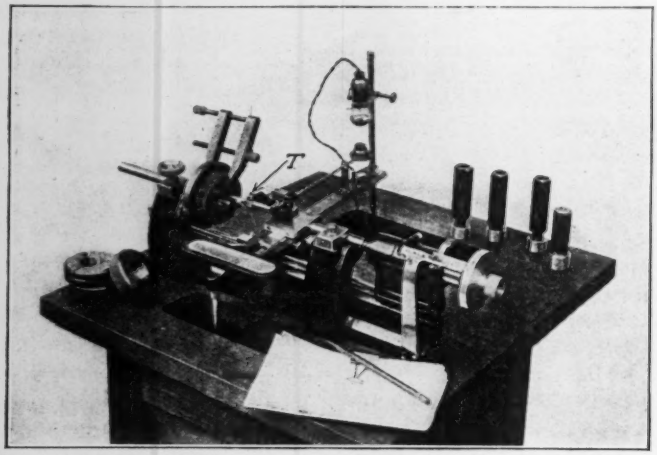

Fig. 6 Method of Measurement of Pitch or Lead of a Ring Thread Gage

thread. These formulæ, as generally given, result in securing an answer which should check with the outside or full diameter of the screw being measured. The effective diameter is not mentioned in these formulæ and this often leads to confusion. Reference will therefore be made here to a simplified formula for 60-deg. threads which results in the direct computation of the effective diameter. This formula is as follows:

$$E = M + \frac{0.8660}{N} - 3G$$

where E = effective diameter
M = measurement over the wires
N = number of threads per in.
G = diameter of wires.

In the use of this formula the term $\frac{0.8660}{N}$ may be computed for various pitches and the computations simplified. The general formula which may be used for any size of wire which will fit in the thread and which takes into account the helix angle of the thread for precision measurements, is as follows:

$$E = M + \frac{\cot a}{2N} - G\,(1 + \sqrt{\operatorname{cosec}^2 a + s^2 \cot a})$$

where $a = \frac{1}{2}$ the included angle of thread
G = diameter of the wires
s = tangent of the helix angle.

The above formula involves squares and square root of functions and therefore is awkward for making computations, and the following formula, which is an expanded approximation, but which is accurate to better than one hundred thousandth of an inch, is more convenient:

$$E = M + \frac{\cot a}{2N} - G\,(1 + \operatorname{cosec} a + \frac{s^2}{2} \cos a \cot a)$$

It should be noted that the error due to the first or simple formula rarely equals 0.0001 in., and then only when the helix angle is large.

Precautions in Making Three-Wire Measurements

It has been claimed that measurements of effective diameter made by the three-wire method result in values which are smaller than those secured by other means, such as by thread micrometers. This contention is probably justified in some cases and may be due to insufficient care in making measurements. It is important in making measurements that as little pressure as possible be applied on the wires with the measuring micrometers. Since the wires rest in a V-thread, a given pressure exerted on the top wire will have a magnified effect of distorting the wire where the contact is made on the sides of the thread. This will result in the measurement over the wires being less than it should be. Furthermore, if the wire is standardized under a light pressure and then used with a larger pressure, the diameter of the wire which is substituted in the formula for computing the effective diameter will be larger than it should be. This difference is multiplied by the factor 3 in the formula and the tendency is to make the result small. Excess pressure is often placed upon the wires during the measurement by use of ratchet or friction stops on micrometers, or by an unskilled operator, and sometimes on account of the arrangement of the wires and the screw thread when the measurements are taken. It is poor practice to support the screw being measured on two wires which are in turn supported on a horizontal surface, for if the screw is of large diameter the weight of the screw causes a distortion of the wires and interferes with the measurement.

One of the pieces of apparatus used in measuring gages by the three-wire method is shown in Fig. 4. This apparatus is known as a balanced micrometer. In operation the screw is supported between centers as shown, and the micrometer is supported on a counterbalanced arm which is in turn carried on a cylinder resting in a V-groove parallel to the centers. As originally designed, as shown in Fig. 4, the micrometer was constrained perpendicular to the axis of the thread being tested and two wires were used. The arm supporting the micrometer was overbalanced so that a slight upward pressure was given to the micrometer in order to hold a wire at the bottom of the thread and allow the operator to insert the top wire and make a reading with ease and rapidity. After using

this constrained micrometer for some time, it was found preferable to pivot the micrometer clamp on its supported arm so as to allow a slight movement in a vertical plane passed through the axis of the screw thread and then use three wires instead of two. For this arrangement two wires are carried at the bottom and one wire inserted at the top of the thread as before. This apparatus is very simple in construction and is recommended as being very convenient where a large number of gages are to be tested.

Another form of apparatus for making wire measurements using two wires is shown in Fig. 5. This instrument was specially designed and constructed for the Bureau of Standards. It embodies a precision bench micrometer accurate to within about two one hundred thousandths of an inch, supported on a heavy base and carried by steel balls. This support permits the micrometer uniform contact on the wires at either side of the thread. This machine has been found useful for threads of relatively large diameter. The instrument is of massive construction, and its rigidity, which is not common to ordinary measuring instruments, permits, when precautions are taken to avoid temperature changes, measurements which are accurate to within two or three one hundred thousandths of an inch.

TEST OF RING THREAD GAGES

The measurement of ring thread gages presents many problems owing to the difficulties with which observations may be made on the various elements. While there are various ways and means of obtaining the measurements required, it is not possible in most cases to work to the degree of accuracy that is obtainable in measuring plug thread gages. Very often the special apparatus required for such measurements is not available in commercial shops, and it then becomes necessary to judge the perfection of the ring thread by the way which it fits on a male check or checks. The various operations required for measurement are quite similar to those given for plug gages. The procedure generally embodies the following operations:

1 Measurement of pitch or lead
2 Measurement of angle and form of thread
3 Measurement of full diameter
4 Measurement of core diameter
5 Measurement of effective diameter.

MEASUREMENT OF PITCH OR LEAD

The measurement of pitch or lead of a ring thread gage is accomplished as shown in Fig. 6. The same apparatus is employed for measuring ring threads as for measuring plug threads, with the exception that an extension stylus or attachment is provided to project into the ring and transfer the motion of the auxiliary stylus to the ball stylus used on the plug thread. This auxiliary device is shown at *T*, Fig. 6. Instead of being supported on centers, as is the case when a plug is tested, the ring is clamped on a faceplate and the operation then is exactly the same as previously explained for measuring the lead of the plug thread.

MEASUREMENT OF ANGLE AND THREAD FORM

The measurement of angle and thread form of ring threads is accomplished with the projection lantern in a similar manner to that employed in measuring angle and thread form of plug threads. In this instance, however, it is necessary to obtain first a cast of the thread to enable the projection to be made. The casts usually used are made of a composition of sulphur and graphite containing about 7 per cent by weight of graphite. The graphite is added to eliminate reflections which would be encountered on the surface of a plain sulphur cast in the process of projection. Then, in addition, the graphite has a tendency to reduce the shrinkage of the sulphur upon cooling. The procedure in making the cast is to clamp the ring in a vise, the jaws of which have been ground smooth, and pour melted sulphur into the ring, obtaining a cast which is a segment of a circle. The outfit required for this purpose and illustrations of the cast secured are shown in Fig. 7. The operation of pouring the casts with this method is very rapid. After the casts are poured they are immediately marked with a steel stylus with a number corresponding to the test number on the gage. The measurement of the angle is made as soon after making the cast as possible, inasmuch as experiment shows that the cast warps but slightly during the first five or six hours, but that the warping is considerably greater if the cast is not measured at the end of 24 hours.

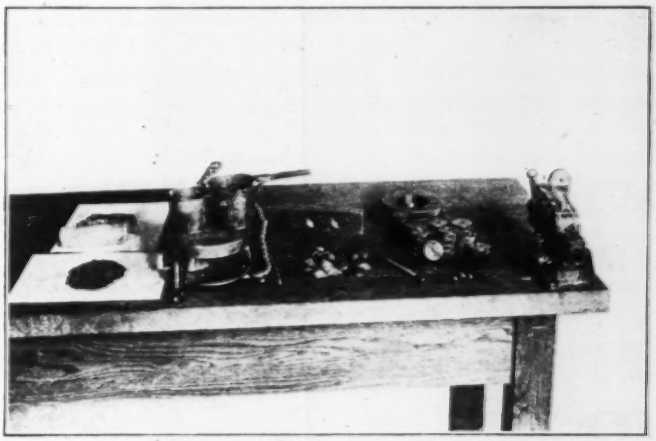

FIG. 7 CAST OF THREAD AND OUTFIT REQUIRED FOR MAKING IT

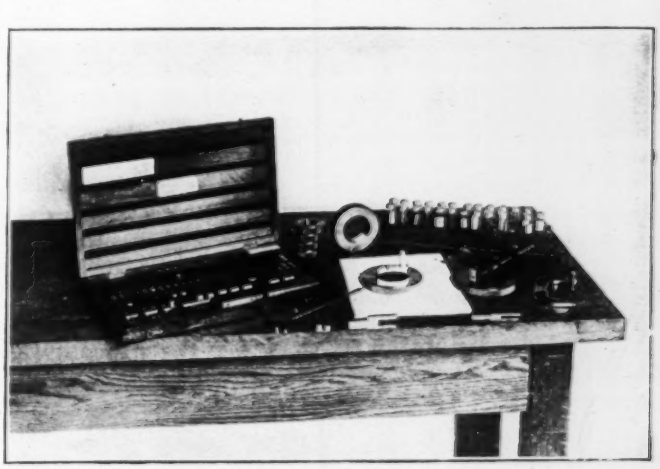

FIG. 8 THREE-BALL METHOD OF MEASURING EFFECTIVE DIAMETER OF A RING THREAD GAGE

MEASUREMENT OF FULL DIAMETER

The measurement of full diameter is usually made part of the projection operation, as was the case of the measurement of the core diameter of plug gages. Here again it is only necessary to insert a templet in the thread to ascertain whether or not the thread has been properly cleared.

MEASUREMENT OF CORE DIAMETER

The measurement of core diameter is usually made with an

inside micrometer, Johansson inside set-up, or by the use of go and not-go plain check plugs for this diameter. This measurement of a plain inside diameter requires no further explanation.

Measurement of Effective Diameter

The method which is usually employed for measuring the effective diameter of a ring gage is by judging the fit of a gage on a plug thread check. This plug check is ordinarily ground off at the crest of the thread in order to make sure that the plug touches on the sides of the thread instead of at the crest. It is usually considered that when the ring fits snug on the plug the effective diameter of the ring is the same as that of the plug. This assumption, however, is not strictly true, inasmuch as there always is certain variation between the lead or pitch of the plug and the lead or pitch of the ring, and furthermore, variations of angle between the plug and ring are always present. Both of these variations necessitate the ring's having an effective diameter larger than the plug upon which it fits snugly. In most cases the amount actually required for fit, due to differences in pitch and angle, is appreciable, sometimes as much as several thousandths of an inch. In order to ascertain the effective diameter where check thread plugs are not available, the three-ball method of measurement has been adopted. In making these measurements the ring is laid on a flat surface with the axis of the thread perpendicular. Two balls are then placed in adjacent threads and a third ball is placed diametrically opposite. The distance between these balls is then taken by inserting size blocks together with a taper parallel, Fig. 8. The effective diameter can then be computed in a manner similar to that explained for male screw threads, as it is necessary to change only the sign of the different quantities of the formula as previously given for wire measurements. The formula as corrected for the change of sign is then as follows:

$$E = M - 0.8660 \times p + 3G$$

where E = effective diameter
M = measurement between balls
p = pitch in in.
G = diameter of balls.

This formula applies in cases where the balls used touch nearly at the mid-slope of the thread.

THE CONSERVATION OF HEAT LOSSES FROM PIPES AND BOILERS

By GLEN D. BAGLEY,[1] PITTSBURGH, PA.

THE purpose of this paper is to present a more complete and detailed method of solving the problems involved in the calculation of the heat losses from bare and covered pipes and the economic problems encountered in the practical application of coverings. The factors in the economic calculations are: the cost of the heat, the cost of the covering, the size of the pipe, the temperature of the pipe, and the temperature of the atmosphere. It is necessary to consider all these factors together in order to obtain a correct result.

The data contained in the paper are a part of the results obtained in an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research. The assistance received from the Association and from the Administrative Staff of the Institute has materially aided in the successful progress of the investigation, and credit is also due to Mr. G. F. Gray, who was originally in charge of the work, and to Mr. R. H. Heilman, who has assisted in securing the data.

It is generally recognized that the losses from bare pipes and boilers are considerable, but the real magnitude of these losses is little appreciated. The fact that the loss from 1000 sq. ft of exposed surface at 100 lb. per sq. in. steam pressure amounts to over 300 tons of coal annually is sufficient justification for serious consideration of the subject.

Heat Losses from Bare Surfaces

In a study of the conservation of losses, the first important fact to be considered is the actual value of the losses from bare surfaces. It is often considered that the loss from any bare surface is 3 B.t.u. per sq. ft. per hr. per deg. fahr. temperature difference between the surface and the surrounding air. While this value is correct for some special cases, it is by no means generally so. Most investigators have confined their measurements to one size of pipe at one temperature difference. Both the size of pipe and the temperature difference have an important effect on the value of this constant. Paulding in his book on Steam in Covered and Bare Pipes has worked out the theory of heat losses from bare pipes from the researches of the French physicist Péclet. The curves of Fig. 1 show the application of this theory to horizontal pipes. The solid curves indicate Paulding's values, while the dotted curves and the points give the results of various experimental tests.

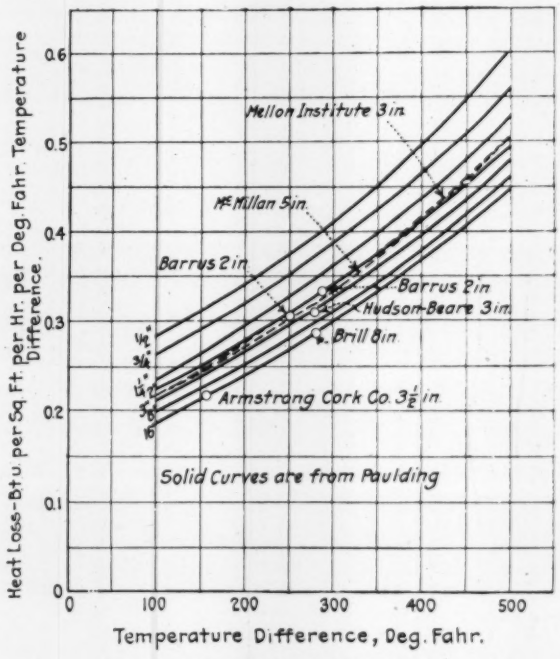

FIG. 1 HEAT LOSS FROM BARE PIPE

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It seems that Paulding's curves give the best average values for use in calculating heat losses. They show that the constant may vary from 50 per cent below 3 B.t.u. per sq. ft. per hr. per deg. fahr. to values far above it. At 500 deg. temperature difference, which is often attained with superheated steam, the constant increases to double this value for the smallest size of pipe. In some chemical plants steam is used at temperatures of 1100 deg. fahr. The importance of using very thick insulation at these temperatures is easily judged from the rate at which the loss is increasing at 500 deg. fahr. It is to be noted that these values are all considerably higher than the values given in Kent for losses from bare surfaces.

Heat Loss from Insulated Pipes

The next important point in a consideration of the conservation of heat losses is the value of the loss after the pipes are insulated. In the apparatus used in determining these values at the Mellon Institute, the case of the heater, shown in cross-section in Fig. 2, consisted of three pieces of 3-in. pipe, the middle section being 3 ft. long and each end section 1½ ft. long. The sections were connected by heat-insulating disks of asbestos board and each end section was provided with a hemispherical cap of cast iron. Inside of each section was an electric heater made by winding resistance wire on a frame of

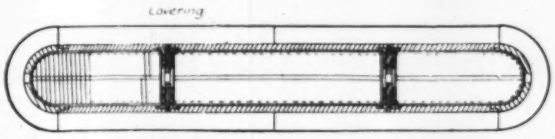

FIG. 2 CROSS-SECTION OF HEATER WITH COVERING APPLIED

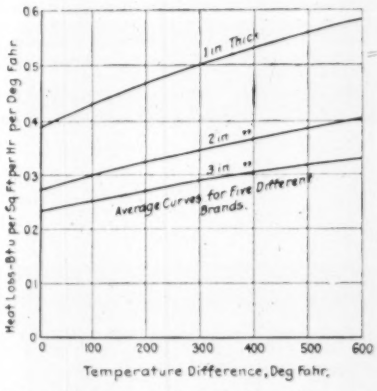

FIG. 3 HEAT LOSS THROUGH 85 PER CENT MAGNESIA COVERINGS ON 3-IN. PIPE

asbestos boards. The wires were finely spaced and close to the inner surface of the pipe.

Results of tests made on five different makes of magnesia, in 1-in., 2-in., and 3-in. thicknesses, are shown in Fig. 3. These curves are all corrected for slight variations in thickness so that they are the true curves for the thickness given. Fig. 4 gives a comparison of the losses from a bare pipe with the losses through coverings 1 in., 2 in., and 3 in. thick. The contrast is very striking. The efficiency increases with the temperature as the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

Method of Conducting Tests

Two standard 3-ft. sections of pipe covering were applied as shown and the ends covered with plastic. This placed half of each section and a joint over the middle section of the heater, a condition exactly similar to actual practice. The currents in the different heaters were then adjusted until the temperatures shown by the thermocouples attached to the surface of the pipe were alike on both middle and end sections. The coverings were dried out for several days until conditions became constant, as shown by the readings which were taken every hour. The average of three consecutive constant readings was then used to calculate the conductivity. The power input was read on an accurate wattmeter and the temperature of the pipe by copper-constantan thermocouples peened into

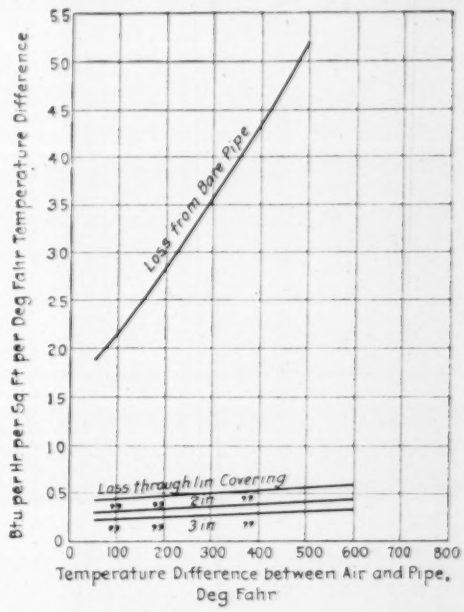

FIG. 4 HEAT LOSSES FROM 3-IN. PIPE WITH 85 PER CENT MAGNESIA COVERING

the surface. Since the end sections of the pipe were adjusted to the same temperature as the middle, there could be no flow of heat in a direction parallel to the axis of the pipe. This obviated the necessity for any kind of end corrections in connection with the conductivity measurements. To obtain the conductivity of any covering in B.t.u. per sq. ft. per hr. per deg. fahr., it was only necessary to convert the power input to the middle section in kilowatt-hours to B.t.u. per hr. and divide by the area of the surface of the middle section in square feet, and by the temperature difference between the air and pipe. The temperature of the air was measured by thermometers suspended several feet from the pipe.

The temperature of the pipe was measured by copper-constantan thermocouples. It was found that the variation of individual samples from the standard curves of the American Chemical Society was so great that it was desirable to calibrate the thermocouples before use. This was done by the boiling-point method, which proved very satisfactory. A Siemens and Halske suspension-type millivoltmeter with a resistance of 889 ohms was used in connection with the thermocouples to measure the temperatures. This apparatus proved very satisfactory and made it possible to take a large number of readings quickly and accurately.

Calculation of Heat Losses Through Coverings

The theoretical calculation of losses through coverings on flat surfaces is quite simple, but the problem of curved surfaces is much more difficult. In this case the effect of the increased cross-section and surface area must be taken into account. Since the conductance is directly proportional to

the cross-sectional area and inversely proportional to the length of the path, it can be shown that the increment of heat loss is

$$H = \frac{2\pi K (T_1 - T_2)}{\log_e \frac{R_2}{R_1}} \quad \ldots\ldots\ldots\ldots [1]$$

where

H = heat loss in B.t.u. per hr. per ft. length of covering
T_1 = temperature of surface of pipe in deg. fahr.
T_2 = temperature of surface of insulation in deg. fahr.
R_1 = radius of pipe in in.
R_2 = outer radius of insulation in in.
K = conductivity of the insulating material in B.t.u. per sq. ft. of cross-section per in. thickness per deg. fahr. temperature difference per hr.

The loss through any pipe covering can be worked out by the use of this equation providing the value of K is known. K varies with the temperature and must be obtained from an

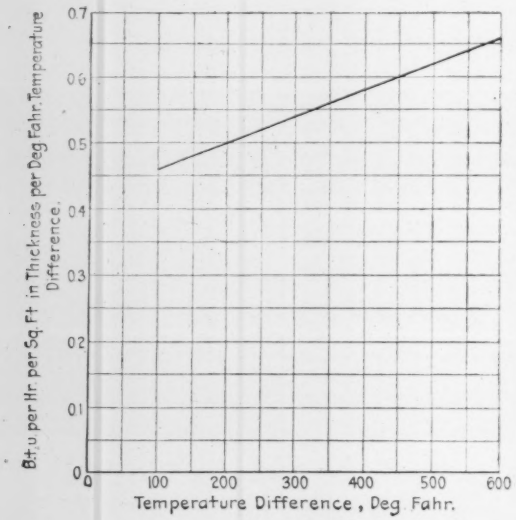

FIG. 5 ABSOLUTE CONDUCTIVITY OF MAGNESIA PLOTTED AGAINST TEMPERATURE DIFFERENCE AT SURFACE OF INSULATION

experimental curve giving the value at different temperature differences above room temperature. The curve for K which was obtained during this research is given in Fig. 5. It should be emphasized that this kind of curve is the only fair basis for comparison of the heat-insulating value of the different kinds of coverings, as all variables due to small differences in thickness, to different sizes of pipes on which tests were made and to different surfaces or room conditions are eliminated. These curves take into account only the conduction through the material as they are based on temperature measurements at the inner and outer surfaces of the insulating material and not on the temperature at the outer surface of the canvas covering or in the air.

The difference in temperature between the outer surface of the insulating material and the temperature of the ambient air is a definite function of the heat transmitted per sq. ft. of the outer surface of the covering and of the kind of protective material used over the insulation. In Fig. 6 is given a curve showing this relation for the canvas covering as ordinarily used for this purpose. This curve was developed by L. B. McMillan at the University of Wisconsin and has been checked during this investigation. To use Formula [1] for a pipe covering in still air, an estimate of the heat loss per sq. ft. of the outer surface of the canvas covering must first be made. From the curve of Fig. 6 an estimate of the temperature beneath the canvas can then be made. Knowing this temperature and the temperature of the pipe, the term $(T_1 - T_2)$ of the formula is determined and the loss calculated. If this checks fairly well with the estimate of the loss from the outer surface, the calculation can be considered to give the proper value for the heat lost. If not, the estimated loss from the outer surface must be changed according to the indication of the calculation and the calculations repeated until the estimated and calculated losses check. This cumbersome process is necessary because of the complicated nature of the flow of heat through the compound insulation composed of the insulating material itself and the protective covering and the effect which the surface finish has on the radiation of heat from the outer surface of the covering.

In case it is desired to compute the loss per sq. ft. of pipe surface instead of per lineal ft. of covering, the formula becomes

$$H = \frac{K (T_1 - T_2)}{R_1 \log_e \frac{R_2}{R_1}} \quad \ldots\ldots\ldots\ldots [2]$$

Table 1 gives the value of the term $R_1 \log_e \frac{R_2}{R_1}$. The physical meaning of the figures in this table is the equivalent thickness on a flat surface of the given thickness on the given size of pipe. For example, a 3-in.-thick covering on a 3-in. pipe is equivalent to a covering 1.75 in. thick on a flat surface.

In connection with this work, an investigation was made to determine the distribution of temperature about a covering in still air. The results obtained show that no considerable error is made by assuming equal temperature distribution at the surface of the insulation in making the calculations.

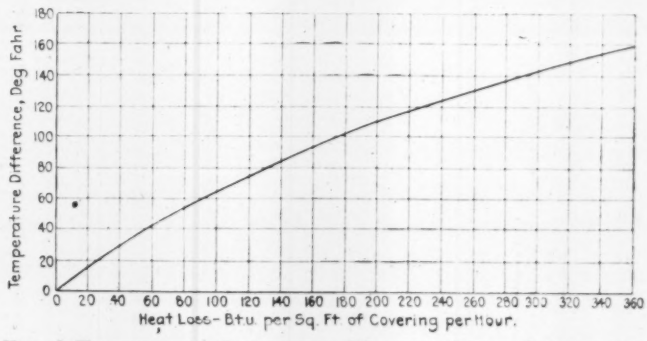

FIG. 6 TEMPERATURE DIFFERENCE BETWEEN INNER SURFACE OF CANVAS COVERING AND ROOM FOR DIFFERENT HEAT LOSSES

EFFECT OF AIR CURRENTS ON HEAT LOSSES

Some tests have been made and others are now in progress to determine the effect of wind velocity on the losses from bare and covered pipes. The apparatus used to determine this effect consisted of a 35-in. Sturtevant blower driven by an 8-hp. direct-current motor which furnished a blast of air for a wind tunnel. The apparatus used for testing pipe coverings was arranged inside of the tunnel so that the axis of the pipe coincided with the axis of the tunnel. This caused the air to travel parallel to the axis of the pipe and gave a condition similar to that encountered in locomotive practice.

The first test was made with a 3-in.-thick magnesia covering on the test pipe, a temperature difference of 460 deg. fahr. between the pipe and the wind, and a wind velocity of 30 m.p.h. Under this condition the loss was 0.430 B.t.u. per sq. ft. of pipe surface per deg. fahr. temperature difference

TABLE 1 EQUIVALENT THICKNESS ON A FLAT SURFACE OF VARIOUS-THICKNESS COVERINGS ON DIFFERENT-SIZED PIPES

Pipe Size, In.	Thickness of Covering, In.				
	1	2	3	4	5
¾	0.560	0.823	0.897	1.130	1.240
1½	0.679	1.073	1.350	1.570	1.740
3	0.790	1.332	1.750	2.080	3.360
6	0.878	1.565	2.135	2.620	3.040
12	0.925	1.740	2.460	3.080	3.680
24	0.960	1.843	2.680	3.400	4.150

per hr. Under normal conditions of still air, the loss was 0.302 B.t.u. This shows an increase of about 40 per cent due to the wind velocity. From a theoretical consideration of the question, it can be shown that the maximum possible increase of loss due to wind will be reached when the temperature below the surface of the canvas covering on the magnesia is reduced to the temperature of the wind itself.

The curve of Fig. 6 shows the temperature beneath the canvas for any condition of loss in still air. When calculations are being made for exposed pipes, the loss should be calculated both by use of this curve as explained before and by using the temperature of the pipe and the temperature of the air for T_1 and T_2. By comparing the loss in still air and the maximum loss which may be caused by wind, an idea of the probable increase due to exposure can be obtained and extra thick insulation applied accordingly. Curves are being worked out to show the per cent increase in loss at various different velocities and different temperature differences.

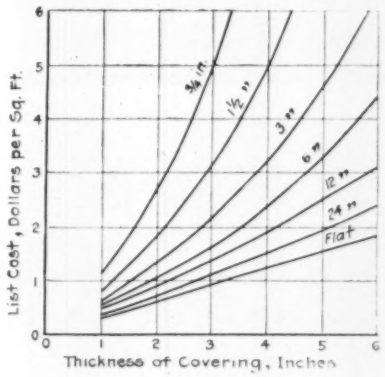

FIG. 7 COST CURVES FOR DIFFERENT-SIZED PIPES

PERMANENCY OF INSULATING QUALITIES OF COVERINGS

The last important point in considering pipe covering is the permaneney of their insulation value. Tests were made on several old magnesia coverings. In the case of a 1-in.-thick covering which had been in service at the Armour Glue Works in Chicago for 8 years, the conductivity was found to be slightly lower than the average of the new 1-in. coverings tested, showing that no deterioration in service had taken place. Several sections were obtained which had been saturated with oil. Tests on these showed much lower insulation values than new coverings. The damage was permanent and shows that care should be used to protect coverings from oil while in service.

INITIAL COST OF COVERINGS

After considering the technical and theoretical side of heat losses from bare and covered surfaces, the next point is the economic side of the problem. In most cases the result desired is the maximum net saving of money for any given condition. If the covering cost were nothing, the proper thickness would be limited only by the requirements of space available, as each increased thickness would result in some slight increased saving in heat. In a practical case where the covering has a

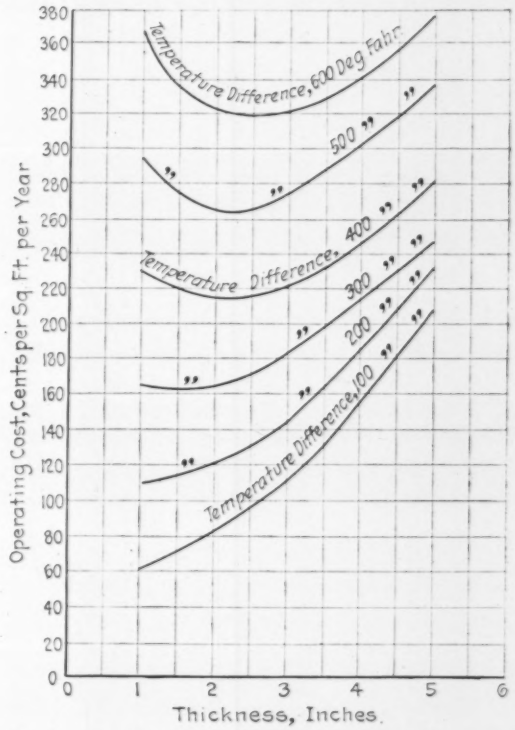

FIG. 8 CURVES FOR ¾-IN. PIPE—STEAM COST, 80 CENTS PER 1,000,000 B. T. U.

TABLE 2 THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

(Thickness in Inches. S = Standard Thickness)

Size Pipe, Inches	Hot Water, 175° F.	Steam, 5 Lb.	Steam, 100-200 Lb.	200 Lb. 150° F. Superheat	200 Lb. 300° F. Superheat
Coal at $2 per Ton					
¾	S	S	S	S	S
1½	S	S	S	S	2
3	S	S	S	1½	2
6	S	S	1½	2	2
12	S	S	2	2	3
24	S	S	2	3	3
Flat	⅞	1½	2	3	3½
Coal at $4 per Ton					
¾	S	S	S	1½	2
1½	S	S	1½	2	2
3	S	S	2	2	3
6	S	S	2	3	3
12	S	S	3	3	4
24	S	S	3	4	4
Flat	2	2	3	4	4½
Coal at $6 per Ton					
¾	S	S	1½	2	2
1½	S	S	1½	2	3
3	S	1½	2	3	3
6	S	2	2	3	4
12	1½	2	3	4	4
24	2	3	3	4	5
Flat	2½	3	4	5	5½
Coal at $8 per Ton					
¾	S	1½	1½	2	3
1½	S	1½	2	3	3
3	1½	2	3	3	4
6	1½	2	3	4	4
12	2	3	3	4	5
24	2	3	4	5	6
Flat	2½	3½	4½	5½	6½

finite cost, a point is soon reached where the increased cost of the covering would be greater than the additional saving in heat effected. The determining of this point is the thing in which the user of coverings is interested, as it is just at this point that the maximum net saving is accomplished.

In Fig. 7 a set of curves is given which show how the list prices of coverings vary with the thickness. By means of these curves the cost per sq. ft. of surface covered can be determined for any thickness desired. From this cost the annual fixed charges due to the covering can be calculated. After considerable investigation, it was decided that 20 per cent of the list price of the covering would be allowed as the cost of application, and 13 per cent of the total cost as the annual charges (6 per cent interest, 5 per cent depreciation and 2 per cent insurance and miscellaneous).

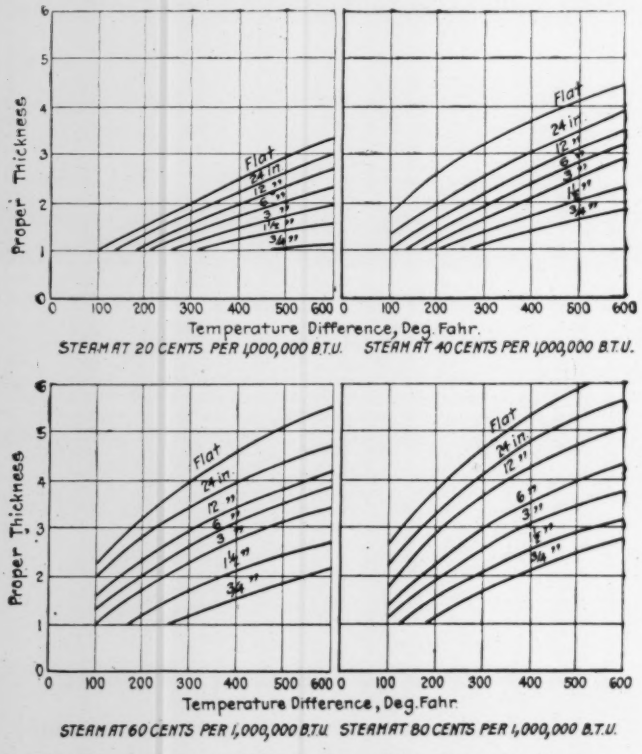

FIG. 9 THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

OPERATING EXPENSES DUE TO HEAT LOSSES

The other cost to be charged to the operating expenses of the covering is the value of the heat losses through the different thicknesses of coverings. The previous work done on measuring the loss through 15 samples of magnesia furnished the necessary data for calculating the loss in heat units. After the heat loss was determined, it was necessary to convert the loss into dollars and cents. The assumptions used in making this conversion were that the cost of coal is 75 per cent of the cost of steam, that 1 lb. of coal as burned will evaporate 7 lb. of water from and at 212 deg. fahr., and that each pound of steam contains 1000 B.t.u. above the feedwater temperature. The value of the heat losses was calculated for seven sizes of pipes, five temperature differences between pipe and air, and four different costs of heat, both on the basis of a known cost per million B.t.u. and on a cost per ton of coal and the average conditions of steam generation given above. By making these calculations both ways, the results are applicable to plants where the steam costs are accurately known as well as to those where accurate records are not kept.

By combining the fixed cost and the heat losses per square foot per year, the total operating expenses were obtained. Once these are obtained, it is simply a matter of picking that thickness which gives the minimum annual operating expenses to obtain the proper covering to use. It is evident that the thickness which gives the minimum operating expense also gives the maximum net saving, as the loss from bare pipe is a constant under given conditions and the net saving is the difference between the operating expense and the loss from bare pipe.

TABLE 3 COAL SAVED BY 85 PER CENT MAGNESIA COVERING 1 IN. THICK

Steam Pressure	Saturated 5 Lb.	Saturated 10 Lb.	Saturated 50 Lb.	Saturated 100 Lb.	Saturated 150 Lb.	Saturated 200 Lb.	200 Lb. Pressure with 100 Deg. Superheat
Steam temperature, deg. fahr.	228	240	298	338	366	388	488
B.t.u. loss per hr. per sq. ft. bare pipe	367	409	625	802	937	1058	1735
B.t.u. loss per hr. per sq. ft. of pipe covered with 85 per cent magnesia	69	76	105	126	142	153	210
B.t.u. saved per hr. per sq. ft. by covering pipe with 85 per cent magnesia	298	333	510	676	795	905	1525
Tons (2240 lb.) coal saved per 10,000 sq. ft. per year of 8760 hr. by pipe covered with 85 per cent magnesia	1190	1330	2080	2700	3180	3620	5650
Cars of coal saved per year, as above, at 40 tons per car	30	36	52	68	80	90	140

Coal efficiency taken at 14,000 B.t.u. per lb. with boiler efficiency at 70 per cent.

TABLE 4 MONTHLY COAL SAVING, IN DOLLARS AND CENTS, BY THE USE OF 85 PER CENT MAGNESIA PIPE COVERING, STANDARD THICKNESS, PER 100 LINEAL FT. OF STEAM PIPES

Size of Pipe, Inches	5 Lb. Steam Pressure	10 Lb. Steam Pressure	50 Lb. Steam Pressure	100 Lb. Steam Pressure	150 Lb. Steam Pressure	200 Lb. Steam Pressure	200 Lb. Steam Pressure, 100° Superheat
½	1.44	1.58	2.20	3.28	3.66	4.11	6.80
¾	1.72	1.89	2.87	3.70	4.26	4.89	8.03
1	2.11	2.30	3.56	4.80	5.35	6.04	10.00
1¼	2.52	2.74	4.22	5.52	6.50	7.25	12.20
1½	2.86	3.10	4.73	6.14	7.29	8.17	13.70
2	3.53	3.74	5.86	7.63	8.93	10.11	16.80
2½	4.25	4.39	6.95	9.07	10.55	11.99	19.90
3	5.00	5.33	8.30	10.90	12.60	14.30	23.82
3½	5.72	6.22	9.60	12.40	14.40	16.32	27.23
4	6.50	7.06	10.60	14.05	16.40	18.40	30.85
4½	7.30	7.69	11.80	15.35	17.92	20.25	34.00
5	7.97	8.64	13.16	17.20	20.00	22.72	38.00
6	9.36	10.15	15.60	20.38	23.82	26.88	44.90
7	10.90	11.70	18.38	23.68	27.60	30.80	52.00
8	12.26	13.22	20.40	26.60	31.20	34.90	58.55
9	13.80	14.70	22.70	29.00	34.52	38.61	64.80
10	15.08	16.33	25.00	32.70	38.40	43.08	72.40
Flat surface, area 100 sq. ft., 1¼ in. thick	5.26	5.67	8.80	11.50	13.48	15.12	25.44

These savings are based on pipes carrying steam for 24 hours per day and 30 days per month. Coal is figured at $5 per ton, delivered.

SELECTION OF COVERINGS TO GIVE LOWEST OPERATING EXPENSE

The way in which the covering which gave the lowest operating expense was chosen was to plot curves of the type shown in Fig. 8 for the total operating expense for five different thicknesses. By selecting the thickness corresponding to the lowest point on each curve, the proper thickness of covering to use for the temperature difference corresponding to that curve was obtained. One set of these curves was plotted for each size of pipe at each of four different steam costs. From this set the thickness curves given in Fig. 9 were derived and from these Table 2, showing the proper thickness in relation to coal cost per ton, was obtained by making the assumption previously explained. From these curves and tables, the proper thickness to use in order to obtain the maximum net saving under any condition may easily be determined.

The saving in coal tonnage and car capacity accomplished by applying 1-in.-thick coverings to 3-in. pipe is shown in Table 3. In Table 4 the saving is expressed in dollars and cents per hundred lineal ft. of pipe per month when covered with "standard" thickness coverings and where coal costs $5 per ton. In this case the saving varies from $1.44 for 100 ft. of ½-in. pipe at 5 lb. pressure to $72.40 for 100 ft. of 10-in. pipe at 200 lb. pressure and a superheat of 100 deg. fahr.

TESTS OF BOILERS WITH AND WITHOUT COVERINGS

In order that the results of the laboratory tests might be checked on a larger scale, several practical tests were made. The first and most important of these was a boiler test made in a mine plant at Bruceton, Pa., where there were two boilers of 80 and 60 hp., locomotive type, having 675 sq. ft. of exposed surface. The tests covered a period of 24 hours. Conditions of load, etc., were practically the same during both tests. During the first test while the boilers were uncovered, 10,784 lb. of coal was burned to evaporate 58,000 lb. of water. In the second test, after the boilers had been covered with 2 in. of 85 per cent magnesia blocks and plastic, 9296 lb. of coal was burned to evaporate 59,500 lb. of water, or 1500 lb. more water evaporated with 1488 lb. less of coal burned. If calculated for an equal evaporation of water, the saving in coal would be 1700 lb. per day. The calculated saving based on the laboratory experiments was between 1400 and 1500 lb. per day. This saving amounts to 15 per cent of the coal burned due to covering the boiler alone, as the pipe lines were not included in the test. (The results of this test were reported in detail at the June meeting of the A.S.M.E. at Worcester.)

It is hoped that the data here presented will be of assistance to engineers and will help in the conservation of the resources of our country.

INDUSTRIAL POWER PROBLEMS

BY W. F. UHL,[1] BOSTON, MASS.

THE two principal sources of power for industrial purposes at this time are steam and water-power plants owned and operated by the industry, the so-called isolated plant; or the purchased electric current from the public-service power companies, the so-called central plant or system.

The principal points which must be considered when provisions for a power supply for an industrial plant are to be made are reliability and cost. The relative importance of these two items is in the order stated and for many plants the last item is comparatively unimportant.

Conservation of fuel, which until recently received consideration only as a part of the cost of power, is now an important factor from a standpoint of reliability also. Within the last year it has become apparent that the important thing is to have power, no matter from what source; and within very wide limits, no matter at what cost.

RELIABILITY

The proportionate cost of power to the total cost of the commodity produced for sale in most industrial plants is below 5 per cent; and, as already stated, reliability is of much greater importance than cost when considering the supply of power for such plants. An analysis of any power situation should therefore first consider the relative reliability of the various sources of power.

When considering reliability, our first thought is generally related to shutdowns. The loss due to complete failure of power supply, when translated into dollars per hour or other time interval, is one of the uncertain quantities which makes the question of reliability so difficult of solution. This loss is subject to determination if we make certain assumptions. For instance, if we have a plant that operates continuously, the loss due to a shutdown can be directly calculated in terms of average profit, plus idle-labor cost, plus spoiled stock in process, plus fixed charges. As most plants do not operate continuously, the time lost during shutdowns can generally be made up, at least to some extent, and the loss may be reduced to the cost of labor only if the nature of the industry is such that stock in process will not spoil.

RELATIVE RELIABILITY

Relative reliability is also somewhat indeterminate, but there are certain factors which have an important bearing on the subject. Ignoring the question of shortage of fuel, which it is hoped is only a temporary problem, and assuming equal reliability of plant, steam power is more reliable than water power, excepting certain noteworthy cases. The chief sources of unreliability of water powers are variability of streamflow, ice troubles and floods. In most cases water power must be supplemented to some extent by auxiliary steam or other source of power to make it equally as reliable as steam power alone.

Relative reliability as between the power obtained from the isolated plant and that obtained from a central plant or system depends upon the following principal factors: (1) Size of plant; (2) reserve capacity; (3) quality; (4) transmission.

Size of Plant. Unless the central plant is several times the size of an isolated plant of 500 kw. or greater capacity, it would be unusual to obtain greater reliability because of the factors which are generally considered as having a tendency

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[1] Hydraulic Engineer. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

to promote reliability merely on account of size. Such factors are—design, quality of supervision, equipment, location, etc.

The average 1000-kw. isolated plant does not receive the attention in design, supervision, etc., that the average 10,000-kw. plant receives, but it would be a mistake to assume from this that all small plants are poorly designed or supervised or that there are no 10,000-kw. plants which are not poorly designed or supervised.

Reserve Capacity. An isolated plant can be said to be thoroughly reliable if it has an installation such that any one unit, as, for instance, prime mover, boiler, pump, etc., can be idle and the plant still carry the entire load. Such a plant might consist of two complete power units, each capable of

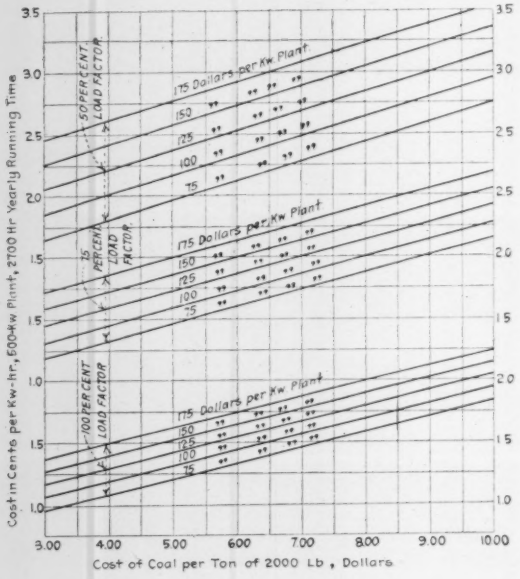

FIG. 1 APPROXIMATE COST OF STEAM POWER FROM 500-KW. ISOLATED PLANT RUNNING 2700 HR. YEARLY

carrying the entire load, and a spare boiler, or three power units, any two of which could carry the entire load if operated at some overload, and a spare boiler.

A central plant to have equal reliability as to reserve capacity must be able to carry its peak load at some overload on about 75 per cent of its rated capacity, depending to some extent on the number and size of units installed. If the isolated plant operates only nine or ten hours a day and is usually shut down over Sunday, it can get along with less reserve capacity than the central plant operating continuously, as there are more opportunities to make extensive examinations and repairs.

Quality. When speaking of quality of power, we refer to those characteristics which affect the speed and efficiency of the motors, such as speed variation and voltage regulation. These characteristics of power also affect both the quality and quantity of the product of many industries.

Speed variation is apt to be less in the average central plant, due to the larger amount of connected load and its diversity. Motors which are large compared with the total load and which carry a variable load are a source of poor-speed regulation, whether connected to the isolated or central plant. Better voltage regulation is usually obtained from the isolated plant because of the absence of transmission lines.

Transmission. The one great weakness of central-plant power service is the necessary transmission. Even if the transmission is of the best and thoroughly protected by placing it in underground conduits or otherwise, it is always a source of possible trouble with which the isolated plant does not have to contend.

Under favorable conditions, this element of unreliability may be almost negligible, but more often, especially with long overhead transmission, it is the greatest source of shutdowns and poor voltage regulation in the present state of the art of power generation and use. It affects those industries most which are liable to have stock in process spoiled, due to shutdowns, or which produce a poorer grade of material on account of ununiformity.

SITUATIONS

It is possible to define a number of fairly common situations of power supply for industrial plants and to determine certain limits that it is well to keep in mind when making a comparison in which reliability, cost, conservation and policy are all considered.

An attempt is made in the following to outline a few such situations and in doing so only demands of power of 500 kw. or more are considered and these entirely in the form of electrical energy.

Situation A. An Industrial Plant Which Has No Water Power and No Demand for Exhaust Steam or Hot Water.

If a reliable central plant having several times the capacity required for the industry in question existed within reach it would ordinarily be policy to purchase power even at some increase in cost over what the power could be produced for in an isolated plant. It may be assumed that the money which must otherwise be invested in a power plant would bring addi-

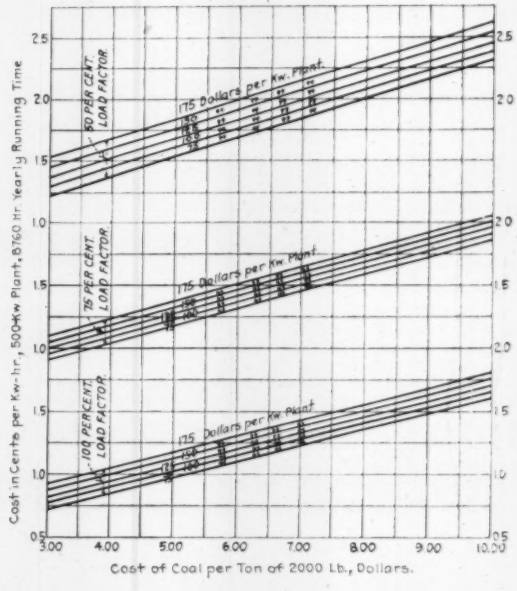

FIG. 2 APPROXIMATE COST OF STEAM POWER FROM 500-KW. ISOLATED PLANT RUNNING 8760 HR. YEARLY

tional profit to the industry if invested in manufacturing machinery, buildings or supplies. The management of the industry could be more specialized and conservation of fuel should also be a result.

The accompanying diagrams, Figs. 1 to 4, give the approximate cost of steam power from small isolated plants under various conditions and form a basis to determine the rate which

it would be policy to pay for purchased power, taking all things into consideration. The load factor in the diagrams is based on the number of hours the plant is in operation. [Additional diagram for plants up to 5000 kw. capacity are given in the complete paper, which is available in pamphlet form.—EDITOR.]

Situation B. An Industrial Plant Which Has a Water Power of Ample Capacity to Carry the Entire Load a Portion of the Time But Must Have Auxiliary Power in Some Form During Low-Water Periods and Has No Use for Exhaust Steam or Hot Water.

The cost of the auxiliary power other than cost of fuel and plant depends largely upon the following:

a Extreme-minimum stream flow, which determines the size of auxiliary plant required.

b Variation of stream flow throughout the year, which determines the number of times the auxiliary plant must be started.

c Fondage available, which determines the uniformity of demand on the auxiliary plant when in operation and the amount of banking of fires.

d Completeness of water-power development, which determines the proportion of the total load to be obtained from the auxiliary plant.

e Proximity of water power to auxiliary plant, which determines the cost of attendance.

Situation C. An Industrial Plant Which Has a Small Water Power, of Insufficient Capacity to Carry the Entire Load at Any Time, and Has No Use for Either Exhaust Steam or Hot Water.

Many industries were started at a time when steam power

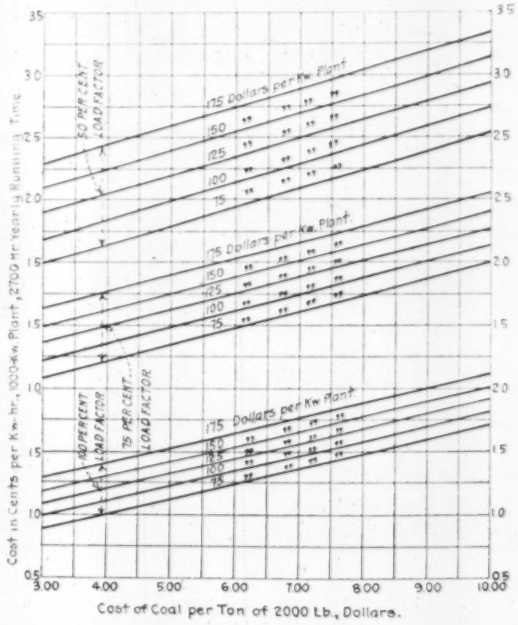

FIG. 3 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. ISOLATED PLANT RUNNING 2700 HR. YEARLY

was inefficient and costly and when the demand for large and constant sources of power was not so important as at present. This naturally led them to locate where water power could be developed at small cost and which would serve all their purposes for the time being. Most of these industries which proved successful soon required larger and more constant sources of power than could be obtained from their local water power, and in many cases the water power soon became a very small portion of the total power required. Very few of these small water powers were abandoned where the industry itself prospered, although in many cases they would be found to operate at a loss if all proper charges were made against them. With others the use of water for condensing and manufacturing purposes required the maintenance of dams, ponds and other structures, which made it possible to consider a large portion or all of the fixed charges against such structures as properly chargeable to other parts of the industry than water power, thus again making the water power a profitable source of power.

Electrical transmission of power has made it possible to

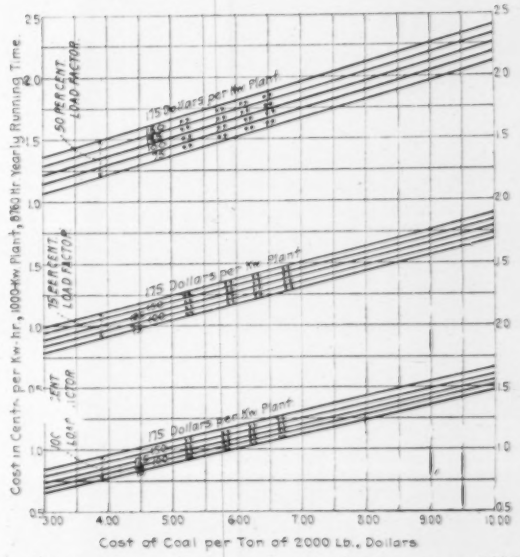

FIG. 4 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. ISOLATED PLANT RUNNING 8760 HR. YEARLY

utilize many of these small water powers more fully, and in some industries where there often is necessity for overtime, night and Sunday work in some departments a small water power is valuable to carry such loads when it would otherwise have to be carried by a steam plant at inefficient part load and at considerable cost in attendance.

Such water powers may be the means of completing stock in process at a vital time, or of filling valuable orders, or keeping together at least a small part of an organization when other sources of power fail.

Unfortunately, measured in the light of improvement in the art of hydroelectric development in recent years, most of the existing small water powers and many larger ones are extremely inefficient. One of the greatest sources of fuel conservation exists in the redevelopment of water powers electrically and efficiently. Twenty to thirty per cent more power can frequently be obtained from the same amount of water and to this must be added the saving due to electrical transmission and the saving in wasted water on account of the more flexible use of the power.

It is evident from the foregoing that the value of these small water powers can no longer be determined from a purely investment standpoint, in which the cost of a certain number of kilowatt-hours produced by the water or by water and steam is compared with the cost of obtaining the same number of kilowatt-hours from a straight steam plant or from purchased power. The problem is more complex and must include power reliability and fuel conservation.

The cost of the power required by an industry other than

that obtained from its own water power in a situation of this kind is largely governed by the same limitations that have been mentioned under the previous situation. If such additional power is obtained from a steam plant, supplementary to the water power or to which the water power may be supplementary, the size of the steam plant depends upon the extreme minimum water power available. The load factor on the steam plant depends upon the amount of water power available and to some extent upon the use made of it. Pondage, if wisely used, will decrease the size of the steam plant required and increase the load factor under which it operates.

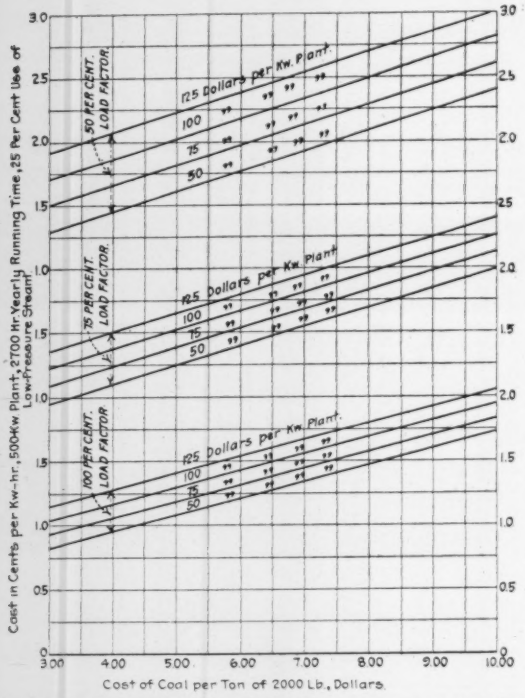
Cost in Cents per Kw-hr., 500Kw Plant, 2700 Hr. Yearly Running Time, 25 Per Cent Use of Low-Pressure Steam
50 PER CENT. LOAD FACTOR
75 PER CENT. LOAD FACTOR
100 PER CENT. LOAD FACTOR
125 Dollars per Kw. Plant
100 " " " "
75 " " " "
50 " " " "
Cost of Coal per Ton of 2000 Lb., Dollars.

FIG. 5 APPROXIMATE COST OF STEAM POWER FROM 500-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 25 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

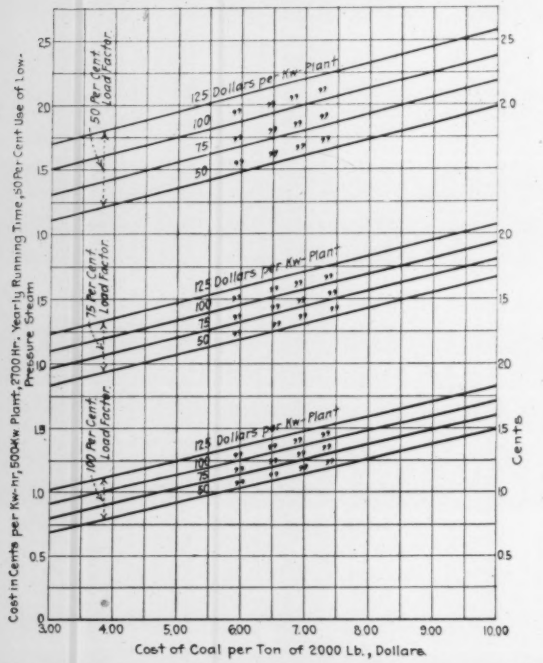
Cost in Cents per Kw-hr, 500Kw Plant, 2700 Hr. Yearly Running Time, 50 Per Cent Use of Low-Pressure Steam
50 Per Cent. Load Factor
75 Per Cent. Load Factor
100 Per Cent. Load Factor
125 Dollars per Kw. Plant
100 " " " "
75 " " " "
50 " " " "
Cents
Cost of Coal per Ton of 2000 Lb., Dollars.

FIG. 6 APPROXIMATE COST OF STEAM POWER FROM 500-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 50 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

There is a large field for fuel conservation in connection with water powers, attached to industries which operate for only 2700 to 3000 hr. annually. Either reciprocal relations should be worked out between such plants and central plants or the central plants should lease the water powers and furnish the lessor with the power required at a proper cost. The lessor could furnish the attendance at very small cost in most cases.

Situation D. An Industrial Plant Which Requires All or More than All of the Heat Which Can Be Made Available from a Steam-Power Plant in the Form of Either Low-Pressure Steam or Hot Water or Both.

Occasionally an industry is found where conditions are such, or the processes of manufacture can be arranged to be such, that the practicable supply of low-pressure steam can all be used. The demand need not necessarily be the same as the supply as long as it is always larger, as the additional supply can easily be obtained from the boilers by means of an automatic differential reducing valve connected in between the high- and low-pressure steam mains.

As nearly all industries require some high-pressure steam for certain processes, all steam is generally made at high pressure and the pressure reduced by means of reducing valves. It is evident that the steam-power cost in such a case may be comparable to the cost of water power obtained from a plant where there are no water charges, provided the first cost of the plant is about the same. It should be noted that the cost of the steam-producing part of the steam-power plant in such a case is not chargeable to power, as it would be required in any case.

Situation E. An Industrial Plant Which Can Use Only a Portion of the Heat Which Could Be Made Available if All Power Required Were Made By a Steam-Power Plant.

This is a common situation. Very often the total heat required for manufacturing purposes is in excess of that which could be made available from the prime movers, but either the demand or supply, or both, are variable and the situation cannot be developed to maximum efficiency. In other cases only a portion of the heat available is required, which may vary all the way from the plant which has use for exhaust steam only for a few months a year for building-heating purposes, which may be as low as 25 per cent of the total, to the

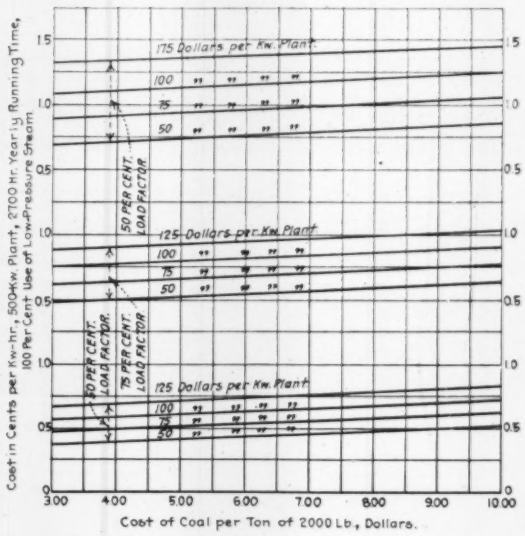
Cost in Cents per Kw-hr., 500Kw Plant, 2700 Hr. Yearly Running Time, 100 Per Cent Use of Low-Pressure Steam
175 Dollars per Kw. Plant
100 " " " "
75 " " " "
50 " " " "
50 PER CENT. LOAD FACTOR
125 Dollars per Kw. Plant
75 PER CENT. LOAD FACTOR
Cost of Coal per Ton of 2000 Lb., Dollars.

FIG. 7 APPROXIMATE COST OF STEAM POWER FROM 500-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 100 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

plant which would properly come under the preceding situation.

Many combinations of prime mover and accessories are possible to best develop a given set of conditions, among which are the following:

a Simple non-condensing engine or turbine, where the exhaust is used either entirely as low-pressure steam or partially for heating water.

b Compound condensing engine, where low-pressure steam is obtained from a receiver between the high- and low-pressure cylinders and where required hot water may be obtained from the condenser for purposes for which it may be suitable.

c Condensing steam turbine of the extraction or bleeder type, where a portion of the steam is extracted near the low-pressure end of the turbine. This low-pressure steam may be partially used to heat water or hot water may be obtained directly from the condenser. Where conditions warrant it, the condenser may be operated so that it will be really a heater rather than a condenser a great part of the time, heating water to suit the demand by varying the amount of condensing water at a sacrifice of vacuum on the turbine.

Figs. 5 to 10 are diagrams giving the approximate cost of steam power from plants of 500 kw. and 1000 kw. capacity operated under various conditions as to load factor and using 25, 50 and 100 per cent of the low-pressure steam available from the prime movers. When making comparisons between cost of power as given in these diagrams and those given in Figs. 1 to 4 for straight condensing steam plants, proper allowance should be made for the cost of that portion of the boiler plant which is not chargeable to making power.

There would be an opportunity for coal conservation as well as for financial gain in many situations of this kind, if the central plants would take over the isolated plants of such industries and tie them in with their distribution systems, operating them to the best advantage of all concerned. Efforts

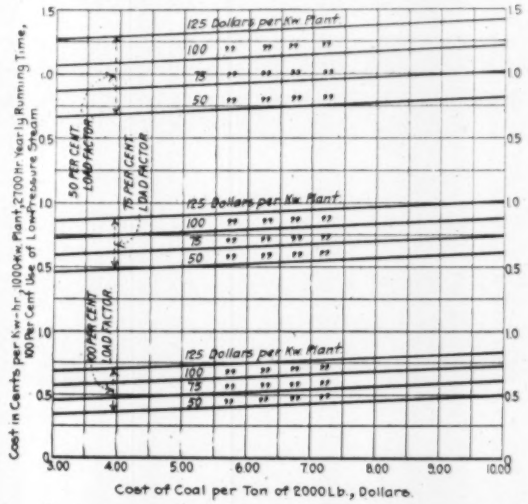
125 Dollars per Kw Plant
100 " " " "
75 " " " "
50 " " " "
50 PER CENT. LOAD FACTOR
75 PER CENT. LOAD FACTOR
100 PER CENT. LOAD FACTOR
Cost in Cents per Kw-hr, 1000 Kw Plant, 2700 Hr. Yearly Running Time, 100 Per Cent Use of Low-Pressure Steam
Cost of Coal per Ton of 2000 Lb., Dollars
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

FIG. 8 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 100 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

leading to such arrangements would seem to lead to better results than those which are aimed at shutting down isolated plants entirely. A common complaint coming from many industries is that they are burning nearly or quite as much coal since shutting down their steam-power plants and purchasing power as they did when running with steam.

In large industrial plants which cover much ground, the expense connected with the installation of low-pressure steam piping of sufficient size to carry the required amount of steam without excessive pressure drop and the loss of heat by radiation and condensation will sometimes be such that the use of low-pressure steam will not be warranted if it is to be supplied from a single steam plant. In such a case it is generally cheaper to use high-pressure steam for at least the

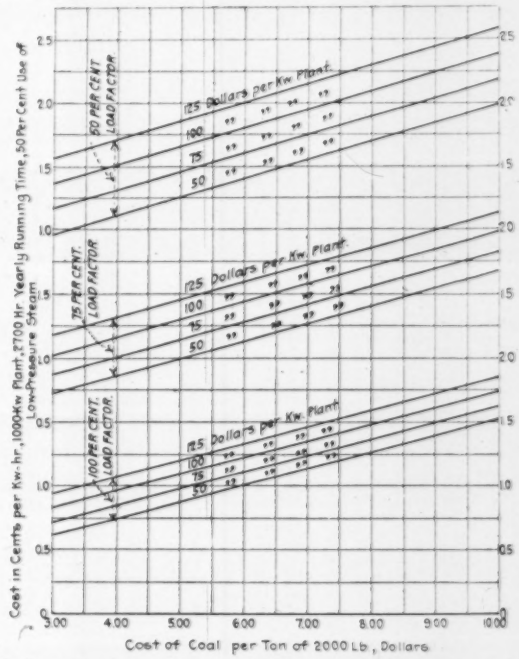
125 Dollars per Kw Plant
100 " " " "
75 " " " "
50 " " " "
50 PER CENT. LOAD FACTOR
75 PER CENT. LOAD FACTOR
100 PER CENT. LOAD FACTOR
Cost in Cents per Kw-hr, 1000 Kw Plant, 2700 Hr. Yearly Running Time, 50 Per Cent Use of Low-Pressure Steam
Cost of Coal per Ton of 2000 Lb., Dollars
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

FIG. 9 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 50 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

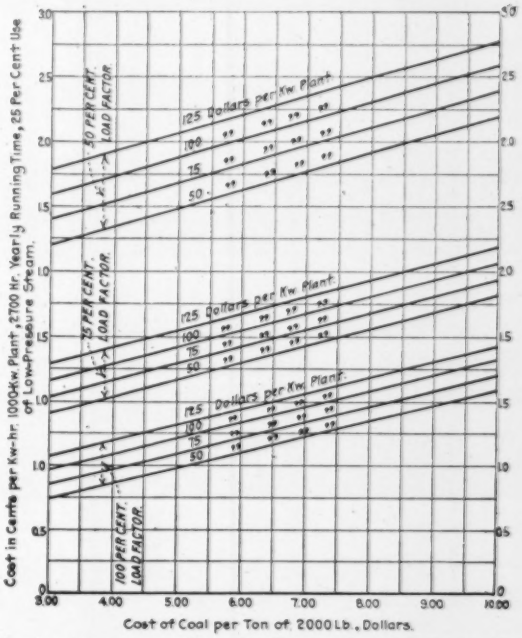
125 Dollars per Kw Plant
100 " " " "
75 " " " "
50 " " " "
50 PER CENT. LOAD FACTOR
75 PER CENT. LOAD FACTOR
100 PER CENT. LOAD FACTOR
Cost in Cents per Kw-hr, 1000 Kw Plant, 2700 Hr. Yearly Running Time, 25 Per Cent Use of Low-Pressure Steam
Cost of Coal per Ton of 2000 Lb., Dollars
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

FIG. 10 APPROXIMATE COST OF STEAM POWER FROM 1000-KW. PLANT RUNNING 2700 HR. YEARLY AND USING 25 PER CENT OF THE LOW-PRESSURE STEAM AVAILABLE

more remote parts of the industry and sometimes for all and obtain the power required from a plant operating as a straight condensing plant or by purchase from a central plant.

Situation F. An Industrial Plant Which Has a Water Power of Ample Capacity to Carry the Entire Load a Portion of the Time, But Must Have Auxiliary Power in Some Form During Low-Water Periods and Could Use All

Heat Which Would Be Available from a Steam-Power Plant.

To the cost of the water-power development must be added the cost of the necessary auxiliary plant to carry a portion of the load during low-water periods, ice troubles, backwater, etc. The cost of the power is then the total of the fixed charges, attendance and supplies for both the water power and auxiliary plant, plus the net cost of the power produced by the auxiliary plant. The size of the auxiliary plant and the extent of its output would depend upon the factors already discussed under Situation B. The only conservation of fuel would result from the difference in saving in the 10 to 20 per cent heat loss by radiation in producing the by-product steam power from the continuously operating steam plant and the auxiliary plant. The problem under this situation is generally to arrive at the cost of investment which would be warranted to develop a water power.

Situation G. An Industrial Plant Which Has a Water Power of Ample Capacity to Carry the Entire Load a Portion of the Time, But Must Have Auxiliary Power in Some Form During Low-Water Periods and Could Use Only a Portion of the Heat Which Would Be Available from a Steam-Power Plant.

This situation presents practically the same problem as the preceding one. The expenditure on water power which could be made to arrive at the same yearly cost of power as that made with a steam plant alone, would depend upon the extent of use of low-pressure steam and hot water and the auxiliary plant cost and power required from it.

In the case of large industries where the distribution of low-pressure steam is expensive, the auxiliary plant can sometimes be located near the point of greatest use of low-pressure steam and the balance of manufacturing and heating steam distributed at high pressure. Hot water can more easily be distributed over large areas than low-pressure steam. Very often the question of condensing-water supply and coal delivery will dictate the location of the auxiliary plant, with the result that all manufacturing and heating steam is distributed at high pressure.

Situation H. An Industrial Plant Which Has a Small Water Power, of Insufficient Capacity to Carry the Entire Load at Any Time, and Which Would Have Use for All Heat Made Available By a Steam-Power Plant at All Times.

Most small water powers operating under the above conditions would show a loss if all proper charges were made against them. The probability of making a water power of this kind pay for itself lies in its possible operation for overtime work and in carrying a part of the load in case of breakdown of the steam plant or in case of shortage of fuel.

A pond of some size and electrical development increase the possibilities of advantageous use of such small water powers under the above situation.

Conservation of fuel would result from the use of the water power for overtime work, if the steam plant could be completely shut down during such times.

Conclusions

Reliability of power supply is of much greater importance to the average industry than the cost of power. If the cost of power were doubled, it would be hardly noticed on the balance sheet of many industries, but shutdowns and speed drop or variation of speed may make a decided difference.

Cost and reliability being nearly equal, it would ordinarily be policy to purchase power where available. If the central plant from which the power is purchased is relatively large and has a fair load factor, this would tend toward fuel conservation.

Where an industry requires considerable heat for manufacturing and heating purposes, power can generally be made cheaper than it can be purchased, and fuel would also be saved by making rather than purchasing power in such a case.

Water power owned by an industry in many cases bears the same relation to it as does purchased power. If it is located at the industry it is often a form of reliability insurance to maintain a water power, even if there is no apparent saving due to its use.

Water powers that save coal should be maintained in any case, and there is a splendid opportunity to save fuel by redevelopment of inefficient water powers.

There exists a field for fuel conservation and financial gain for both central plant and industry, in the possibility of isolated-plant operation by the former.

In the case of water powers owned by industries running only eight to nine hours a day, the saving is of decided importance.

Under certain conditions the saving which would result from central-plant operation of isolated steam plants is also considerable.

FACTORY STAIRS AND STAIRWAYS

By G. L. H. ARNOLD,[1] NEW YORK, N. Y.

IN the multi-story factory, the stairway is a detail worth much more than passing notice. Bear in mind that the people above the first floor are dependent on the stairs for egress; that four times daily the stairs are crowded by people in a hurry; that a large percentage of the minor accidents, many of the serious ones, and many panics happen on the stairs.

A poorly designed stairway may be an effective way to spread fires, smoke or false alarms and is sure to be a disturber of the heating system. A properly designed and located stairway affords not only a safe and convenient means of entrance and exit but also the handiest and most effective vantage point from which to fight fires on the upper floors.

In solving the stairway problem, consideration must be given

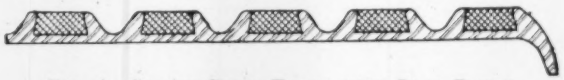

Fig. 1 Safety Steel Tread with Lead Plugs

to: (1) number; (2) location; (3) size; (4) type; (5) materials; (6) safety treads; (7) proportions; (8) landings; (9) handrails; (10) enclosures; (11) lighting; (12) wear.

1 Number

Where building codes are in force, the minimum number of stairways permitted is usually ample. Perhaps the most usual

[1] Mechanical Engineer, 37 Wall St., Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

code requirements are one stairway plus one for each 5,000 sq. ft. of lot area.

In cases where the code provision is insufficient, and where there is no code, it is essential to consider: (*a*) safety; (*b*) capacity; (*c*) convenience.

Safety. No building over two stories in height is safe with less than two stairways. A single stairway may, at a critical moment, be blocked by a temporary disarrangement of stock or fixtures on the floor, by repairs or by a fire.

Large floors require an increased number of stairs even if but few people occupy the floor. As the distance of the extreme point from the stairway increases, so do the chances of floor barricades. Furthermore, in case of panic, fire or other accident, the time required to walk or carry an injured or fainting person 100 ft. or more may be enough to produce serious results.

Two 4-ft. stairways for buildings having up to 20,000 sq. ft. of floor area, with one additional 4-ft. stair for each additional 10,000 sq. ft., is the least number that it is prudent to use.

If the building is liable to be used for purposes which may permit the occupants to be closely spaced, the number should be increased to two for the first 12,000 sq. ft. plus one for each additional 6,000 sq. ft.

At least one and preferably all of the stairways should be carried to the roof.

Capacity. In densely populated buildings the number of stairways must be increased to prevent dangerous overcrowding when all the occupants try to leave at once. In such cases, 20 in. in width for each one hundred persons, the Boston rule for theater exits, is high, and 10 to 14 in. would be ample.

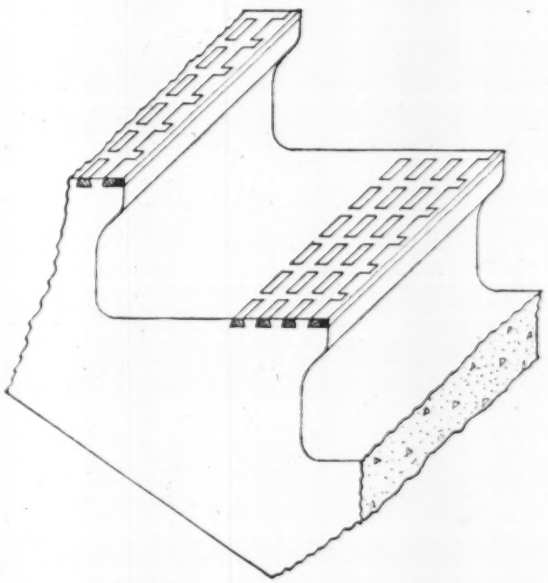

FIG. 2 LEAD SAFETY TREAD IN CONCRETE STAIRS

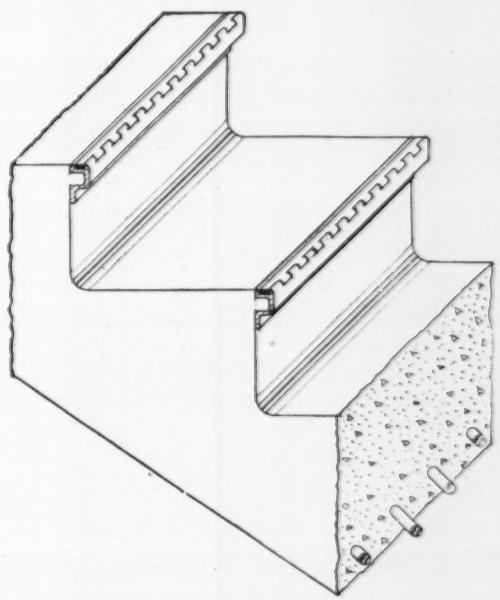

FIG. 4 ABRASIVE SAFETY NOSING FOR CONCRETE STAIRS

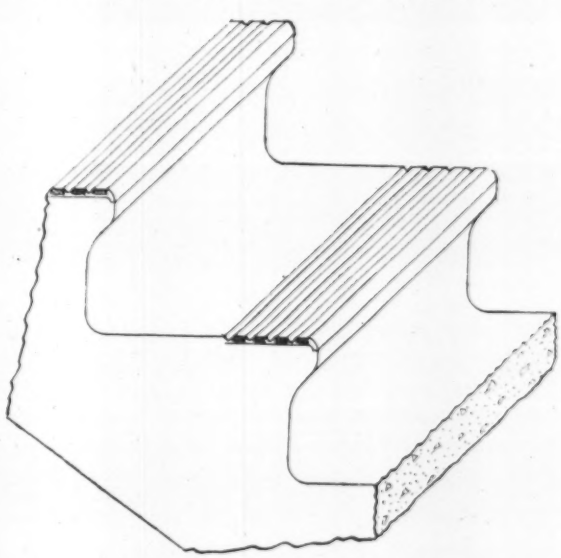

FIG. 3 LEAD SAFETY TREAD IN CONCRETE STAIRS

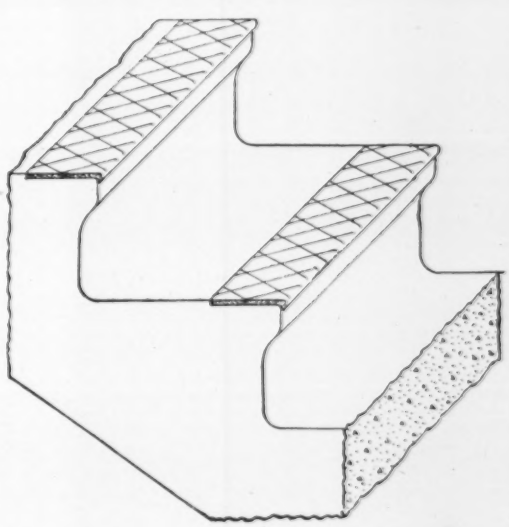

FIG. 5 ALUNDUM OR CARBORUNDUM SAFETY TREAD

Convenience. Avoiding the disturbance of discipline and the loss of time caused by the passage of people through other departments, especial arrangements on one or more floors, the need of accommodating the building to the shape of the plot, the location of exits, and the advantageous subdivision of floors among different tenants or among different departments of the same tenant, may make it desirable to increase the number.

No question of convenience should be permitted to cause stairs to be so located that any occupant of a factory would be obliged to travel over 100 ft. to reach an exit.

2 Location

In the matter of location, many items should be considered. Every stairway should communicate directly with an exit from the building. The stairs should be distributed with a fair degree of uniformity and so placed as to reduce as much as possible the maximum distance to be traversed to reach an exit.

On each floor the landing should be so placed that lines of men going from shop to locker room, locker room to stairs, and shop to stairs, should not conflict.

It is also highly desirable to avoid obstructing the foreman's view of the room. When practicable, the separate tower or

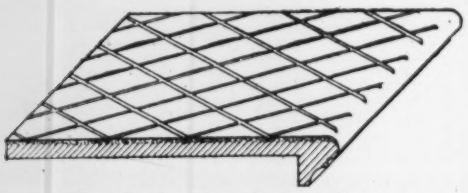

Fig. 6 Abrasive Safety Tread

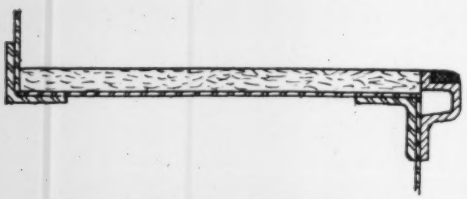

Fig. 7 Nosing for Cork Tread

wing is the most satisfactory location. The locker and toilet rooms and the elevator can be in the tower, thus leaving the main building clear of obstructions and giving the foreman an unobstructed view of the room and permitting greater freedom in the floor layout.

3 Size

A clear width of 44 in. to 48 in. between handrails will allow the passage of two lines of people at once and the main stairs should never be less than this. If wider, the width should be in multiples of 22 in. to 24 in., the number of handrails being such that it is never less than 44 in. nor more than 48 in. between rails.

Where the number of employees is large, it is better to increase the number of 4-ft. stairs than to increase the width. Even when the number of employees in a building is large, only one floor, as a general thing, will be densely populated. This crowded floor is as likely to be at the top as at the bottom. Therefore, it is the usual practice to make factory stairways of constant width throughout their entire length.

Occasionally a factory building must be designed to accommodate dense population on two or more floors. In this case the employees from the upper floors coming down at the full capacity of the stairways will find the lower flights already taxed to the utmost and serious congestion will result. The remedy is increased widths for the lower flights.

Additional stairways from the lower crowded floors may not cure the trouble because, in the excitement of an emergency, when free and quick egress is most important, the occupants of the lower floors are likely to rush to the busiest stairway and leave their own special exit unused.

Special stairs, not used for general ingress and egress, may be as narrow as 20 in. in clear width; they may be steep, or, if not much used, they may have winders or be spiral.

4 Type

Except for special cases used by but few people for intra-department shortcuts, spiral stairs and winders should never be permitted in a factory. Straight runs alone are permissible. When the story height exceeds 9 ft., the flights should be cut and intermediate landings used. The landings should be rectangular and the flights should be not less than three risers nor more than 9 ft. high.

The intermediate landing is of little use if the flights are in line. A turn at the landing serves to limit a fall. A 180-deg. turn has the further advantage of reducing the floor space required. In fact, the stairway of minimum floor area (barring spirals) has a landing and a 180-deg. turn every 4 ft. in its height.

5 Materials

The factory stairs are usually of wood, cast iron, steel or steel with wood tread, steel with cast-iron tread, steel with stone tread, steel with concrete tread, or reinforced concrete.

The wooden stair in multi-story factories is not good practice. It is combustible and unsanitary. In buildings of mill construction, however, especially the smaller ones when not over four stories in height, sprinkled wood may be acceptable. The wood must be smooth, closely jointed, free from beads and not less than 2 in. thick, making a slow-burning construction. It is imperative that the wooden stairs be enclosed in a fireproof well.

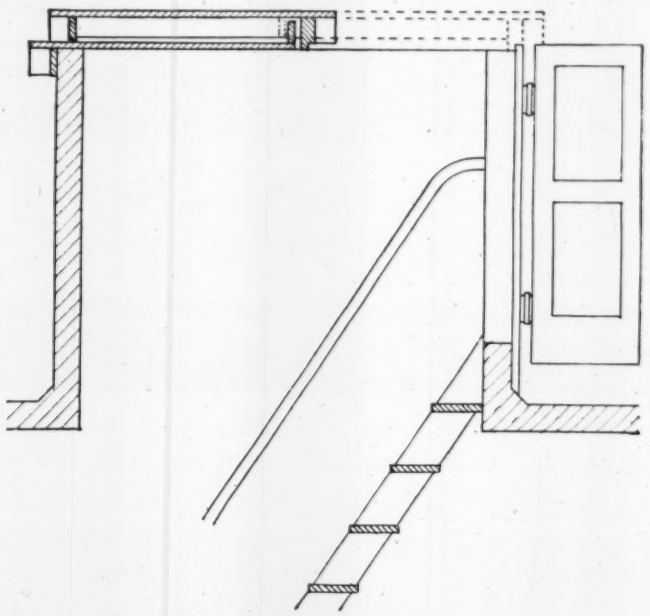

Fig. 8 Penthouse for Steep Stairs

The saving in cost, however, over a non-combustible stairway is not great enough to warrant the risk except in special cases. Cast iron and steel, while non-combustible, are not fireproof. Nevertheless, they are permissible when, as it always should be, the stairway is in a fireproof enclosure, since any fire hot enough to weaken the metals would render the stairway impassable.

Steel channels are more reliable for stringers and, except for short flights, cheaper than cast iron, and are more generally used. Risers are usually of angle and steel plate or pressed steel. Treads, while usually of cast iron, are frequently of checkered steel plate, wood, slate or concrete.

Cast iron and steel plate wear slippery and hence they are dangerous and should never be used without some sort of safety tread.

Wood, because of its imflammability, should not be used except as a safety tread over a solid sub-tread. Slate does not wear slippery but it is more expensive. It must be backed up by steel plate and replacements are expensive.

Concrete as a tread on steel stairs has no special advantage. The steel plate under tread is needed as it is for wood or slate, and to facilitate casting the steel is usually carried up to form a nosing. This is dangerous. The concrete is liable to crack off or wear below the top of the steel, leaving a lip over which, sooner or later, some one will trip and fall.

Reinforced concrete makes perhaps the most satisfactory stair if properly designed and built. There should be a good fillet between tread and riser for sanitary reasons, at least. There should be a nosing, which is not difficult to cast if made with a large fillet.

6 Safety Treads

Steel, cast iron, and concrete wear slippery and so become dangerous. Consequently, some form of safety tread must be used. Safety treads are made of: (*a*) lead; (*b*) abrasive material; (*c*) a combination of the two; (*d*) cork; (*e*) wood.

Lead Safety Tread. The lead safety tread is made by inserting plugs of lead in pockets in a steel frame, Figs. 1, 2, 3, the whole being fastened to the tread proper by screws. This of course wears more rapidly than cast iron or steel but does not become slippery and has no affinity for ice or snow. It is easily replaced when worn. The chief objections to it are that, owing to the grooves between the lead plugs, it is difficult to keep clean, and there is a chance for a heel to catch in the grooves.

Abrasive Safety Tread. The abrasive tread is made of alundum or carborundum cast into hard metal, leaving the grit projecting slightly above the surface of the metal, Figs. 5 and 6. The abrasive is also imbedded in the rounded nosing to prevent slipping on the edge of the step.

This type of safety tread is made to be used as the complete tread as well as the renewable safety tread bolted to a sub-tread. It is also made as a nosing, this form being especially useful on concrete stairs, Fig. 4.

This is probably the most durable tread in heavy traffic. It is, however, hard and noisy and, like the lead tread, it is difficult to keep entirely clean. There is also a chance that the grit may be too sharp: Instances are known where the shoe has been gripped so firmly as to cause a fall.

Combined Lead and Abrasive Safety Tread. A third type of safety tread is made of grains of abrasive in a lead matrix, the whole carried on a steel plate. It is made either grooved or flat, and with the anti-slip surface carried to the front edge.

The flat top is a great advantage as it makes it possible to keep the stairs clean. For outdoor use, it shares with the lead tread the advantage that snow or ice do not adhere. It also shares with the other type of abrasive tread the danger of too acute a grip.

With either of the above three types of tread, it is not necessary to cover the entire width of the tread. If the front edge of the step to a depth of 3 in. to 3½ in. is protected by a non-slipping surface, the remainder of the tread only needs to be brought up flush with the safety strip.

Cork Tread. Cork as a safety tread is not so well known nor so widely used as it deserves to be. It is impervious to almost all liquids and hence is easily kept in a really sanitary condition. It is noiseless, wears surprisingly well and is the pleasantest of all materials on which to walk.

Unfortunately, its lack of strength makes it necessary to use a metal or wood nosing. This is not dangerous, however, because owing to the elasticity of the cork, the nosing will wear ahead of it.

Where stairs are liable to rough usage, as by dragging heavy pieces up or down, the cork tile is sometimes used with a nosing having a lead or abrasive non-slip surface. See Fig. 7.

For use as a safety tread, the cork is compressed into tiles ½ in. thick by 9 to 12 in. sq. These are cemented to the sub-tread.

Wood Safety Tread. Except under the heaviest traffic, wood makes a splendid safety tread. Laid directly on top of a solid steel or concrete base and exposed only on the top and front edge, the fire risk is practically eliminated.

Wood offers one of the most satisfactory surfaces to step on. It is never slippery and it is cheap. The worst objection to it is from a sanitary viewpoint because it absorbs expectoration.

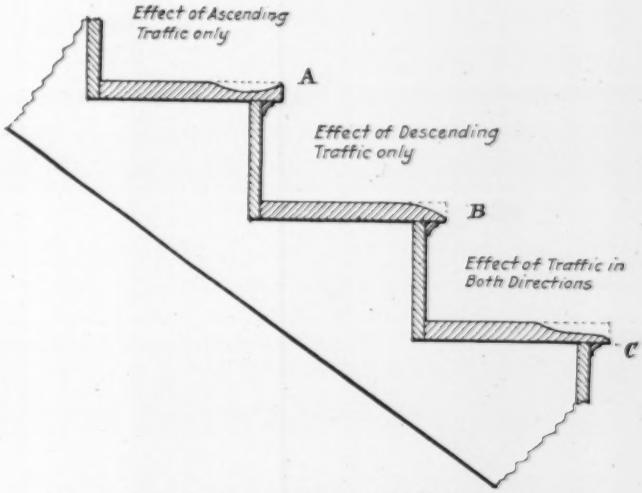

FIG. 9 CHARACTERISTIC EFFECTS OF WEAR ON STEPS

The wood should be either oak, maple or edge-grain yellow pine to wear well, the last-named being undoubtedly the longest-lived. Each tread should be made in three pieces. The rear strip will never need to be renewed and the center strip but rarely.

7 Proportions

Although the pitch of stairs must be kept within comparatively narrow limits for best results, still it is possible to make a safe and reasonably comfortable stair at almost any pitch if due regard is paid to relation of rise to length of run.

The natural length of steps decreases rapidly as the grade increases, even on a ramp where the surface offers equal foothold at all points.

Failure to take this fact into consideration results in a stair which is awkward and tiresome, with a pronouneed tendency to produce stumbling and falls.

The length of the foot, or rather of the shoe, is not an important factor. For one thing, the actual length of the tread exceeds the run by the amount of the nosing. For another, practically all the work of ascending and descending stairs is done by the ball of the foot. In ascending the weight is borne on the ball of the foot in the middle of the step while the heel projects in the air. In descending, the toe projects, the weight being borne on the ball on, or just back from, the edge of the step, the heel barely touching the step.

For adults, making the length of the run plus twice the rise equal to 24 in. to 24½ in. can be relied upon to give satisfactory proportions.

By this rule, the rungs of a ladder should have a 12-in.

spacing, which is the recognized standard, and a 45-deg. stair would have an 8-in. rise and an 8-in. run, which a wide experience shows to be entirely satisfactory. A horizontal grating would have a 24-in. spacing, which, although a trifle short, is nevertheless within the bounds of practicability.

In factory practice, the tendency is to make the stairs steep in order to save room. Observation by several people over a period of years and under a wide variety of circumstances confirms the opinion that an 8-in. rise by an 8-in. run is the steepest stair practicable for general use and that 7½-in. rise by 9-in. run is much better. Some building codes prescribe 7½ in. as the maximum height of run. Although 7-in. rise by 10-in. run makes probably the easiest of all stairs, the improvement over 7½ in. by 9 in. is not usually worth the extra floor space consumed.

Out-of-doors stairs or steps should be made with only 6-in. rise, if possible. In any case, the rise and run must be uniform throughout the entire length of the stairway. Otherwise, falls will be frequent.

8 Landings

All landings should be rectangular and at least as deep as the stairs are wide. The surface should be of the same material as the stair treads. Attempts to save room by cutting off corners or reducing the size of landings, or by the introduction of winders or straight steps invariably result in accidents, especially when the stairs are crowded and every one is in a hurry.

9 Handrails

Each line of people on the stairway should have a continuous, firmly supported handrail at a convenient height and of such size and shape as to be readily and securely grasped.

The material may be wood or metal. If of metal, the rail will usually be iron or occasionally brass pipe and of 1½-in. or 1¼-in. iron-pipe size. The 1¼-in., although somewhat small, has the advantage that the fittings are more generally carried in stock. Large sizes are used but they are objectionable as they cannot be grasped securely in the frantic effort to recover from a misstep, especially by a person with small hands.

T-bars and special rolled, drawn or cast handrail sections, are frequently used but, except for the architectural effect, they have no advantage over the cheap and homely wrought-iron pipe.

If the rail is of wood, it should be of oak, ash or some other non-splintering hardwood; never yellow pine. It may be a round bar not less than 1¾ in. in diameter nor more than 2¼ in., or it may be one of the stock patterns carried by the mills.

In any case it must be strongly supported at a height of 31 to 33 in. above the front edge of the step. Around the landing, the height should be 36 in.

Open stairs require either a second rail at half height or a strong wire netting between stair and rail.

10 Enclosures

Notwithstanding the fire risk, the danger from things dropped or thrown, the chance for falls and the increased difficulty of heating, open stairways are frequently found in factories.

Every stairway should be enclosed in a fireproof well. In many cities a wire grill is permitted between stairs and elevators in the same well. A solid partition is more satisfactory and pays for the extra room and expense.

Choice of material will be governed by the same considerations as in the case of the other partitions.

The space under the bottom flight must be left open and kept clear unless filled up solid with non-combustible material.

If the stairs extend to the roof, the enclosure should be carried above the roof in the form of a bulkhead or penthouse high enough to allow a door 6 ft. 6 in. to 7 ft. in height.

If the roof flight is a ladder or a very steep stair, the penthouse may be replaced by a scuttle, or better, by a companion as shown in Fig. 8.

The door or scuttle should be hooked, latched or bolted in such a way that, at any time, it can be opened readily from the inside.

The roof of the stair well should be a skylight with a wire netting under the glass to catch pieces of glass in case of breakage.

At each story liberal wire-glass windows with metal frames should be provided so that the whole shaft shall be as light as may be in daylight. The better the illumination is, the fewer days in a year will artificial light be required.

All stairway openings should be closed with Underwriter automatic fire doors opening with the outgoing current. The outside doors need not be fire doors but should open out. Where there is much traffic, the fire doors may be supplemented by glazed double-acting doors.

The locks on all these doors should be such that under no circumstances can a person be locked in.

Care should be exercised to locate these doors so that they may be opened without risk of crowding some one off the landing and so that a stream of people descending cannot prevent them from being opened.

11 Lighting

In the artificial illumination of the shaft, brilliancy is not required but thorough distribution is. A light should be placed at each floor and each turn. The lighting should be in duplicate.

Since there is always a likelihood of a small group of employees being in the place at night after the stair lights are out, it is quite necessary to reduce to a minimum the distance one must grope in the dark. For this reason the electric lights should have double-acting switches at each end of each circuit and the emergency lights, whether gas, candle or lantern, should be so placed that each flight can be lighted on the spot.

12 Wear

Steps, subject to ascending traffic only, wear as shown in Fig. 9, at *A*. If the traffic is descending only, the wear is as at *B*. If subject to traffic in both directions, the wear will be as at *C*.

In any case, renewal of the front third of the tread will usually restore the worn step. At long intervals the middle third may have to be renewed if the traffic is very heavy.

Mr. F. A. Waldron, during the years 1896 to 1906, at the Yale & Towne Manufacturing Co., made extensive experiments on the wear of wooden treads constructed in three pieces. Hard maple, on account of its superiority for flooring, was taken as a basis of comparison. Mr. Waldron's method was to use the hard maple on every other step, putting the wood on trial on the alternate steps. Ordinary yellow pine proved to be very short-lived. Edge-grain yellow pine, on the other hand, proved to be by far the most durable, outwearing the maple two to one.

Where safety treads 3 in. or 3½ in. wide are used, practically all the wear will come on the safety tread and only this will need renewal.

PROPERTIES OF AIRPLANE FABRICS

Methods Used by the Bureau of Standards in Developing a Cotton Fabric as a Substitute for Linen for Airplane Wing Coverings

By E. DEAN WALEN,[1] WASHINGTON, D. C.

THE early coverings of the wings of heavier-than-air machines consisted usually of a plain cotton fabric, coated with a beeswax compound or some sort of glue. Such a covering was not very strong and sagged materially when subjected to pressure or exposed to weather. It became necessary in the development of the planes to cover the wing surfaces with a material of high strength and low weight. Accordingly unbleached linen fabric, woven from yarns spun from flax, was used and found satisfactory, but the supply of linen in the present crisis would not suffice to meet the heavy demands and a search for substitutes was imperative.

Previous difficulties in experiments on cotton fabrics were four: (*a*) low strength per unit of weight; (*b*) low tearing resistance; (*c*) little shrinkage upon application of dope; (*d*) little tendency to retain what little shrinkage they had after doping.

In March 1917 the Bureau of Standards was able to issue instructions to various fine-goods cotton mills covering the construction of cotton fabrics for experimental purposes. In the early part of May 1917 a fabric had successfully passed the laboratory standards, and service tests in the field were started, with very satisfactory results, and the present Grade A cotton fabric was evolved.

In August 1917 a conference between the military authorities and representatives of the Bureau resulted in the Signal Corps Equipment Division's ordering the Bureau to supply necessary specifications for the purchase of 500,000 yd. of cotton airplane fabric.

Recently the standard fabrics were submitted to the English airplane authorities and the results of their tests were astonishingly successful. Since that time the English have adopted the standard Grade A fabric.

An interesting development in this connection was the fact that the Italians, working on the same problem at the same time, produced a fabric which had been used successfully on the battlefield and which differed but slightly from our own as far as thread count and yarn number are concerned.

Before suitable substitutes can be found, it is necessary to determine the requirements which a material must satisfy, together with the properties of the material being substituted. The following discussion treats of the methods of determining the properties of textile materials, from which may be determined their compliance with the requirements of airplane wing coverings.

Method of Covering Airplane Wings

It is thought advisable to discuss briefly the method of covering airplane wings in order that one may follow the discussion with more interest. The frame of an airplane wing is covered with a fabric according to one of the following methods: The fabric is sewed into a piece which is wide enough to cover, and is folded completely over and under, the wing frame. It is then tacked on the three open sides after being stretched just enough to take out the wrinkles. The raw edges of the fabric are then sewed together and the tacks removed. The other method consists in making a pocket of fabric and slipping it over the frame. The open end is then tacked and sewed the same as in the previous case. The system of threads in the fabric may have the following two relations to the major and minor axes of the wing: the warp running from the "leading-in" edge to the "trailing" edge, or parallel to the short or minor axis of the wing; or, it may be put on such that the warp is at 45 deg. to the axis of the wing.

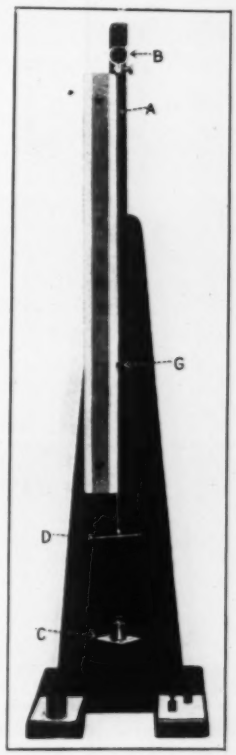

Fig. 1 Instrument for Measuring the Length of Yarn

The fabric is laced to the wing ribs at intervals of about six inches. After the fabric is on the frame, it is treated by means of a brush with a solution of cellulose acetate or nitrate with suitable stablizers, etc., which is termed "dope." The dope has the property of producing a tight drumhead-like wing covering, which is often attributed to the shrinking of the fabric. It also serves to fill in the interstices of the fabric, making a surface which has a coefficient of friction to air approximately equal to that of plate glass. The doped wing fabric may be considered as a rectangular membrane fixed at two sides and supported on the other two sides by the ribs of the frame, and that the wing is composed of many of these sections.

Determinations of the Properties of Undoped Fabrics

Moisture. The amount of moisture is found by drying the sample to a constant weight in a ventilated drying oven main-

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For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

tained at a temperature of 110 deg. cent., and expressing the difference in weight from the conditioned weight in terms of the bone-dry weight. This is commonly termed "regain."

Weight. Pieces of 4 sq. in. are cut from various parts of the sample and weighed after exposure to the standard atmosphere, the results being expressed in terms of weight per unit of area.

Length of Yarn. The length of a yarn is considered to be that length when the yarn is straight and under no tension. The yarn is stressed in tension by equal increments of load and the stretch readings are taken at any particular load when the increments of elongation per unit of time are small. The stretch is plotted against the load. It has been found that after the fibers and the yarn have adjusted themselves the load-stretch curve follows a straight line. The straight-line portion of the curve is extended to intersect the zero-load coördinate, and this length taken to be the length of the yarn when straight and under no tension.

The apparatus is shown in Fig. 1. The yarn A is clamped at one end in the clamp B. The other end supports the weight pan C. The yarn is prevented from untwisting by the cross-arm D. The clip G is an index mark to read the changes in length on the scale F.

Crimp. The crimp of a yarn is the increased length of the yarn taken from the fabric over the length of the fabric. The difference is caused by the interlacings of the yarns. This length of the yarn removed from the fabric is determined in the manner outlined above.

Yarn Count. The yarn count is a term used to designate the size of the yarn and is expressed in terms of length per unit of weight. For instance, a No. 1 cotton yarn has 840 yd. to 1 lb. It may be considered as a very approximate index to the diameter of the yarn.

Thread Count. The thread count is the number of yarns per inch of width of the fabric, and its determination needs no discussion.

Twist of the Yarns. This term is perfectly obvious and needs no discussion. It is determined by counting the turns necessary to untwist the yarn, and the result is expressed in terms of twist per unit of length of the yarn before untwisting.

Tensibility Properties. The tensibility properties of a textile material may be defined as the behavior of the material when subjected to tensile stresses acting parallel to and at the center plane or line of the material. These may be divided into the following: (*a*) load-stretch relations; (*b*) tensile strength; (*c*) restitution and hysteresis.

The tensibility properties are determined in a testing machine of the inclination-balance type arranged to plot autographically the stretch against the load. A diagrammatic sketch of the apparatus is shown in Fig. 2. The inclination balance is represented by the pendulum arm A_1 and the sector arm A_2 which are rigidly connected and pivoted at the point B. The principle is one of balanced moments and its theory needs no discussion. The load applied at D is read on the scale C.

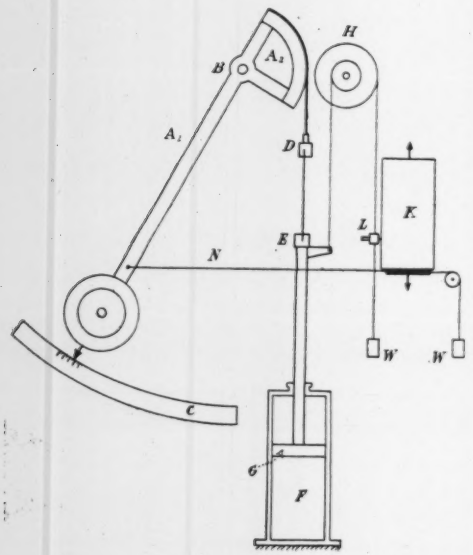

FIG. 2 INCLINATION-BALANCE MACHINE FOR TESTING TENSIBILITY PROPERTIES OF TEXTILE MATERIAL

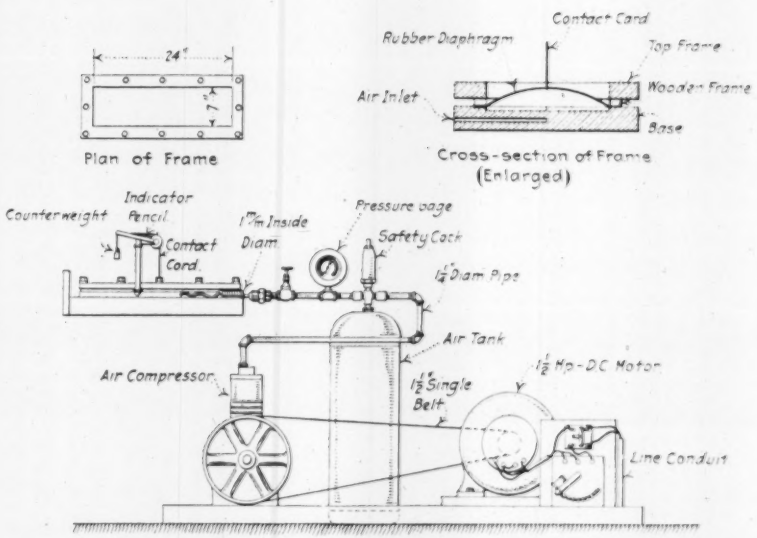

FIG. 3 APPARATUS FOR TESTING BURSTING STRENGTH OF CLOTH UNDER UNIFORMLY DISTRIBUTED PRESSURE

The fabric clamp E, which may be termed a pulling clamp, is operated up or down at will by hydraulic pressure acting on the bottom or the top of the piston G confined in the cylinder F. The motion of the balance arm revolves the drum K by means of the thin, narrow brass ribbon N. The motion of the pulling clamp moves the pen L along the vertical axis of the drum by the ribbon M and the magnifying pulley H. The pen is arranged to make a dot every second. [The paper discusses possible errors of the instrument, for which corrections were made.—EDITOR.]

The tensibility properties are determined in the following manner, which it will be noticed is a deviation from the usual method: Samples of fabric are cut 3 cm. wide by 25 cm. long. These are raveled to 2.5 cm. wide, and allowed to condition. They are then placed in the clamps of the testing machine with 20 cm. between clamps and stressed by reason of their being stretched at the rate of 13 cm. per min.

The tensile strength and load-stretch relations are taken directly from the chart.

The hysteresis and restitution properties are determined by stressing the fabric specimen to a certain load, and relieving the stress in the same manner as applying it. This may be repeated a number of times and the results taken as an index of the fatigue properties of the material.

Tearing Resistance, Tensibility Method. For this particular purpose the tearing resistance is determined in the following manner, which is a slight modification of the English method:

Specimens 25 cm. wide and 36 cm. long are clamped in the testing machine with 30 cm. between clamps. Slits are cut at the center and perpendicular to the line of pull, and the fabric is then stressed at the rate of 13 cm. per min., and the maximum load transmitted is recorded. The length of the slit is plotted against the load recorded.

The maximum length of slit which may be used with this size of sample is determined by the proximity of the zone of stress about the tearing point to the edge of the sample. The area of this zone is easily determined by drawing a series of lines parallel and perpendicular to the line of pull. These lines will be distorted in the zone of stress.

Resistance to Uniformly Distributed Pressure. The material is clamped over a rectangular container and subjected to air pressure. The apparatus is shown diagrammatically in Fig. 4.

The deflection of the center point of the fabric is plotted against the unit pressure under the fabric by means of an ordinary steam indicator. The shape of the deflected surface is determined by measuring the vertical displacement of a series of rods placed at various points over the surface and free to move only in the vertical plane.

The rate of flow of air into the chamber under the fabric is very slow and is regulated by passing the air which is under a pressure of 10 kg. per sq. cm. through 110 cm. of 1-mm. tubing. A sheet of rubber dam is placed under the fabric to prevent air leakage. Considering these precautions, it is reasonable to assume that there is a very uniform distribution of pressure under the fabric. As there is practically a zero rate of flow of air into the indicator, it is reasonable to assume that there is no pressure drop in the connecting line.

In the surface formed by plotting the load-stretch and time relations of a fabric, there is a region where a change in the rate of load application produces only a slight change in the tensibility properties of the material. The rate of load application in this apparatus is adjusted by the definition of the pressure and dimensions of the capillary tube in such a manner that the variations in the load application produce only a very slight difference in the recorded tensibility properties of the material.

Bursting-Tear Test. The procedure is similar to that followed in the determination of the resistance to uniformly distributed pressure excepting that slits are cut in the fabric at various points and the pressure necessary to start the tear is recorded together with the deflection at the time of tear.

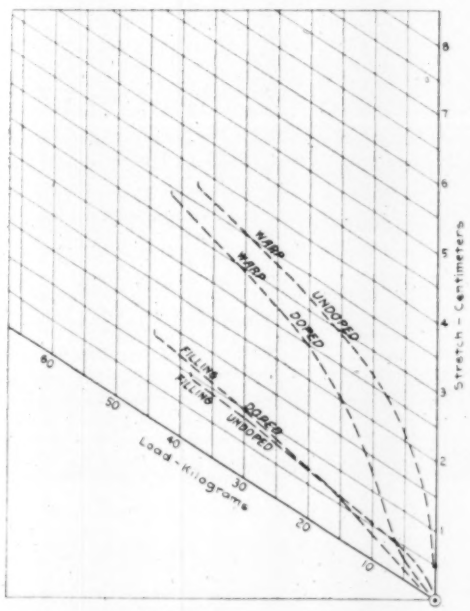

FIG. 4 LOAD-STRETCH RELATIONS OF STANDARD ENGLISH GRADE A AIRPLANE LINEN

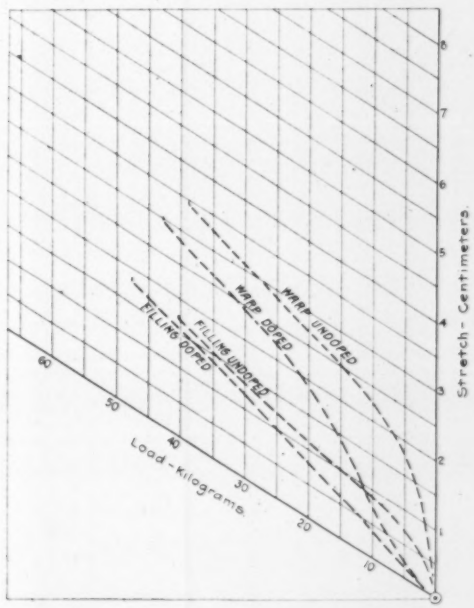

FIG. 5 LOAD-STRETCH RELATIONS OF STANDARD A GRADE COTTON FABRIC

DETERMINATIONS OF PROPERTIES OF DOPED FABRICS

Preparation of Samples. In the tests made by the Bureau of Standards the fabrics were stretched and tacked on frames under a tension of 80 gr. per cm. of width and doped in a room maintained at approximately 65 deg. relative humidity at 21 deg. cent.

The frames were 30 cm. by 30 cm. inside dimensions for the preparation of specimens for the determination of tensibility properties and 18 cm. by 61 cm. for determination of resistance to pressure.

The properties of doped fabrics were determined in the same manner as those of the undoped fabric, with the exception that the tensibility specimens were cut to 2.5 cm. width parallel to the line of threads.

Properties of Dope Films. Films of dope were made by painting the dope on glass plates and the films were subsequently peeled off and determinations made of tensibility and resistance to pressure.

Exposure Tests. The fabrics after tacking on frames and doping were placed on the roof and determinations made periodically of their physical properties.

VALUE OF TESTS

The determinations of weight, yarn size, crimp, thread count and twist are made primarily to explain difference in properties and more particularly to interpret properties in terms which readily adapt themselves to manufacturers' conditions. The effect of these values on properties will be indicated to give the reader a general conception of these effects.

The ability of a fabric to "take the dope" is influenced almost entirely by the relations between yarn number, twist, threads per inch, weight and weave, and they are practically the only measure of such a property. The functions of the dope are to produce a reasonably tight covering, to protect the

fibers from the influence of the atmospheric conditions and to produce a wind-tight surface. In order to perform these functions most advantageously it is necessary that one or two coats of dope penetrate the fabric enough to thoroughly protect the fibers and to serve as a necessary bond for the subsequent coats which should be more of the nature of a surface coating.

Crimp. The crimp of the yarn is the largest determining factor of the load-stretch relations of a fabric, particularly at the lower loads or under conditions of normal flight. This will be discussed under tensibility properties.

Tensibility Properties. The value of tensile strength as a measure of the quality of an ordinary textile material has long

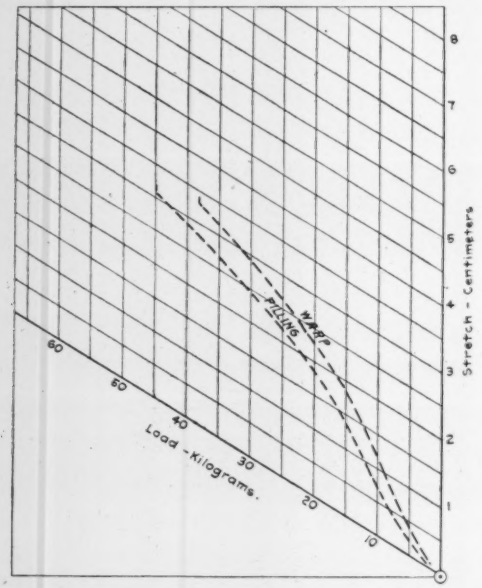

FIG. 6 LOAD-STRETCH DIAGRAM OF A 3/80'S UNMERCERIZED FABRIC DOPE

been realized, and it was largely the fact that this value was solely considered which misled investigators of cotton airplane fabrics.

An airplane-wing covering, for purposes of this discussion, may be considered as a flat, rectangular sheet supported on four sides, and subjected to pressure which may be considered as uniformly distributed over an area defined by the width of the rib spacing in one direction and relatively small distance in the other direction. The stress in the material of the section being considered is a function of the reciprocal of the radius of curvature plus a factor involving what is usually termed as an axial tension load. The curvature at any given pressure is determined by the load-stretch relations of the material, and although the load-stretch diagram does not consider the effect of axial loading, it does serve as a very valuable index to relative factors of safety of the various materials.

The wing covering must be airtight in order that the pressure may not build up on one fabric alone and that flight efficiencies may not be lowered. The material will remain windtight so long as the dope film is not ruptured or deteriorated.

The life of a fabric may be considered to be dependent upon the life of the dope. The dope may be caused to become deteriorated either by repeatedly exceeding its elastic limit or by exposing it to deteriorating rays of light. The latter condition may be reduced to a minimum by coating the material with pigmented varnish or dope which is opaque to the deteriorating portion of the spectrum. (This development may be attributed to an English investigator.)

The shape of the tensibility curves of the doped fabric serves as a valuable index as to whether the elastic limit of the dope will become exceeded under conditions of flight.

The ability of a fabric to shrink depends largely upon its load-stretch relations. The term shrinkage has been applied to refer to fabric tautness and leads to confusion as to the nature of the tightening. It has been observed that the fabrics having the least stretch at the low loads are tightest after doping, and that a plain-weave fabric is tighter than a fabric woven with fewer intersections and having less stretch. The fabric tautness is dependent largely upon the support which the fabric lends to the dope and the completeness with which the dope binds the yarns together in their crimped condition, and is dependent only slightly on film shrinkage.

The necessity of fabric tautness is believed to be largely dependent upon the psychology of the flyer, but, with the present dopes, fabric tightness is almost synonymous with life of the dope or fabric.

The relative recoverable stretch of an airplane-wing covering is quite readily indicated from an examination of the hysteresis loops of the load-stretch diagrams. It was not intended to convey the idea that all degrees of wing-covering looseness were equally desirable, and in the absence of exact data on the effect of fabric looseness on lift and drift, the allowable lack of recoverable stretch must be left to the judgment of the investigator.

The effect of the amplitude of the vibrations of a wing covering is, after a few flights, determined by the recoverable stretch of the material, and here again this phase of the in-

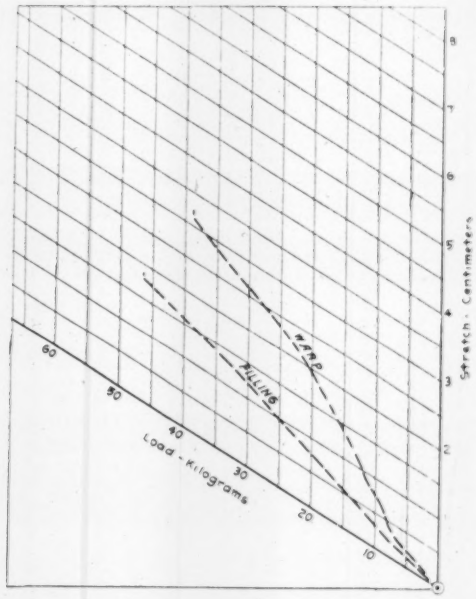

FIG. 7 LOAD-STRETCH DIAGRAM OF A 3/80'S MERCERIZED YARN

vestigation is not complete and the magnitude of this property must be left to the judgment of the investigator.

Tear Resistance, Tensibility Method. This method of determining tear resistance has been considered less applicable to wing-covering materials, as the value of the load-stretch relations is not fully realized, and has been superseded by the bursting-tear method.

The method may be used, however, in cases where the samples are too small for bursting tear and where such apparatus is not readily obtainable.

Resistance to Uniformly Distributed Pressure. As has been already pointed out, the stresses in an airplane-covering ma-

terial are a function of the curvature of the material at any pressure. It has been observed that the tensibility curve obtained by plotting calculated surface tension against stretch of the material during the application of pressure does not agree with the load-stretch diagram. The difference is probably due to the initial stress in the doped fabric and to the fact that the end and side effects of the tension strips are not present in the pressure test.

The test does not include the effect of tensions such as would result from wing deflections, but does serve as a more valuable index to factors of safety than the conventional tensile test. From the pressure-deflection curves it is easier to visualize the relative effect of wing deflection. The true conditions of flight are not duplicated, but the effect of the two systems of yarns are integrated and the results are less deceptive than those obtained from tensile tests.

Bursting-Tear Test. This test like the bursting test is a much better index to relative factors of safety than tension-tear tests. Questions of fabric reinforcement and balance of fabric are readily solved by a careful interpretation of the results obtained from such a test.

RESULTS OF TESTS

Tensibility Properties. The load-stretch relations of a standard English Grade A airplane linen is shown in Fig. 4. It will be noted that the doped filling curve is practically a straight line. The doped warp curve shows a distinct yield point as indicated by the reversal of curvature.

Fig. 5 represents the load-stretch relations of a standard A grade cotton fabric, which, it will be observed, is very similar to the curve of the linen fabric.

The load-stretch diagram of a fabric may be divided into three parts according to the preponderating influences in these particular portions: (*a*) crimp; (*b*) crimp and yarn; (*c*) crimped-yarn characteristics. Referring to the warp load-stretch diagram of the cotton fabric, Fig. 5, the part of the curve extending to approximately 3 kg. is influenced almost entirely by crimp; the curve from 3 kg. to 10 kg. by yarn and crimp; the curve from this point on shows the characteristics of the yarn in its crimped condition.

This analysis suggests the particular part of the manufacturing process which should be varied to produce the desired shape of curve. The part of the curve below 10 kg. may be varied by changing the weave structure, stiffness of the yarn, and more particularly tension, on the yarns during weaving. The sum of the respective stretches of the warp and filling at this point is determined by the weave structure and the relative magnitudes of the respective stretches of the warp and filling are determined by loom tensions.

Fig. 6 represents the load-stretch diagram of a 3/80's unmercerized fabric doped. Both the warp and filling show a dope yield point between 5 and 10 kg. as is represented by the reversal of the curvature of the diagram.

The same construction of fabric made of mercerized yarn is represented by the load-stretch diagram, Fig. 7. The filling diagram does not show a reversal of curvature and the elastic limit of the dope will not be exceeded under normal conditions of flight.

Service tests on these two latter fabrics showed that the unmercerized fabric became somewhat mushy after a short period while the mercerized-yarn fabric stood up very well.

Similar tests on fabrics of various load-stretch diagrams showed that the fabrics whose dope-filling load-stretch diagrams were practically straight lines stood up exceptionally well.

The maintenance of the strength and the tautness of the cotton fabrics is dependent upon the completeness with which the dope protects the fabric and the completeness with which the dope is protected from deteriorating influences such as light and weather.

The dope penetration of the 3/80's fabric, 70 square, plain weave, is excessive. The dope penetration of the 2/60's standard fabric is slightly more than the standard linen fabric.

Excessive penetration of the dope reduces the tear resistance materially. If the standard 2/60's fabric is woven in a 2 by 2 basket the dope penetration is such as to cause an extremely low tear resistance. The small crimp in such a fabric makes it dope up very tightly.

Bursting Test. The curves, Fig. 8, represent the pressure-deflection properties of the center point of the fabric when subjected to air pressure, as previously described.

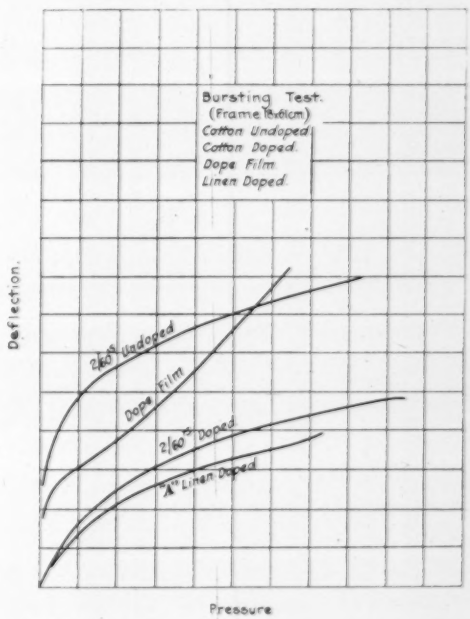

FIG. 8 DEFLECTION OF CENTER POINT OF FABRIC WHEN SUBJECTED TO AIR PRESSURE

The deflection at any load of the fabric undoped is larger than that of the dope film. The deflection of the doped fabric is less than the deflection of either the fabric or the film. This further substantiates the theory that tautness is produced by the dope constraining the yarns in their crimped condition, and that in the standard fabrics the elastic limit of the dope is not exceeded.

It will be observed that the cotton fabric is capable of resisting more pressure than the linen, and it will have, therefore, a higher factor of safety. The fabric tautness is practically the same as that of the linen.

Tear Resistance. From an examination of the distortion of the lines about a tear, it is concluded that the tear resistance is a function of the strength of the individual yarns and the number being stressed. The number of yarns being stressed is dependent upon the load-stretch relations of the fabric and the weave structure.

[Other examples of tests are given in the complete paper.—EDITOR.]

Further experiments are being conducted to determine the properties of airplane fabrics, which have to do with the calculation of the exact performance of any fabric under any assumed condition of flight and which will include the effects of various rib spacings, wing deflections, vibrations, and the effects of various fabric structures.

MECHANICAL FEATURES OF THE VERTICAL-LIFT BRIDGE

By HORATIO P. VAN CLEVE,[1] NEW YORK, N. Y.

THE first important vertical-lift bridge was built in 1892 over the south branch of the Chicago River, at Halsted Street. Its span is 130 ft., it provides for city-highway and electric-railway traffic, and lifts 140 ft., affording vertical clearance for boats of 155 ft. This bridge is illustrated in Fig. 1.

The dead load is counterbalanced by a set of weights connected to the lift span by wire ropes which pass over grooved sheaves on the tops of the towers. The operating machinery is located under the roadway, at the base of one of the towers,

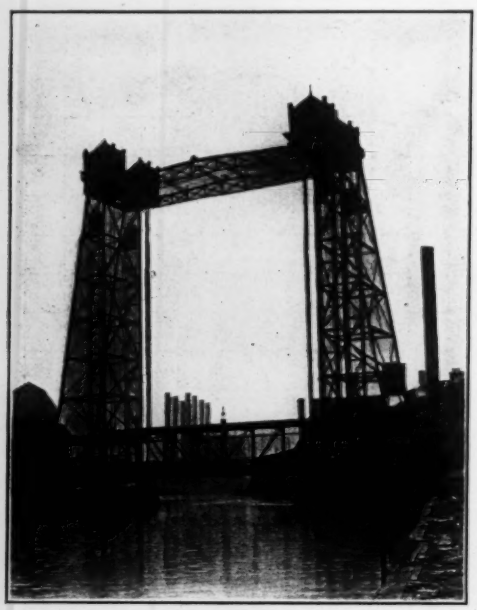

FIG. 1 HALSTED STREET BRIDGE OVER SOUTH BRANCH OF CHICAGO RIVER, CHICAGO, ILL.
130 ft. span, 140 ft. lift. Design of J. A. L. Waddell, Kansas City, Mo.

and the power is transmitted by a system of wire-rope drives running from the grooved drums in the machinery house to each end of the lift span, and to each counterweight. There are 16 ropes in all. Eight up-haul ropes, passing around a set of idlers at the bottom of the near tower, are carried to its top, where they divide into two groups. Four turn downward over another set of sheaves and attach to the near end of the lift span, and four, running horizontally to the top of the far tower, are there deflected downward and attach to the far end of the lift span. The eight down-haul ropes are connected in similar manner to the tops of the counterweights.

The towers, 217 ft. high, are steadied by well-braced lattice girders, which serve also as a support for the idler sheaves placed midway between towers to guide and steady the horizontal reaches of the operating ropes.

In the second structure of this type, of 229 ft. span and 40 ft. lift, built in 1909 across the Mississippi on the line of the Iowa Central Railroad near Keithsburg, Ill., several improvements were made on the operating mechanism of the Halsted St. bridge. Chief among these was the change in the location of the machinery from the pit below the tower to the top of the lift span. This shortened materially the length of operating ropes and reduced to a minimum the complications in their connection and arrangement; and it put the operator at once in reach of his machinery and in view of the river and approaching trains.

The scheme of operation, that used on nearly all succeeding lift spans, is as follows: The motor, in this case a gas engine, is connected by a train of gears to four spirally grooved operating drums, two over each top chord. Two operating ropes are fastened by rope clips to each of these drums, one for the upward movement of the span and the other for the downward, and are so wound on the grooves of the drum that the up-haul rope is wound on while the down-haul rope is paid off, and vice versa. An up-haul rope runs from each drum to the corresponding corner of the lift span, there over a double-grooved deflector sheave, and thence to the top of the tower, to which it is connected. The down-haul rope parallels the up-haul as far as the deflector sheave, and there, passing downward over the other groove in the latter, connects to the tower at a point in convenient reach of the deck.

Rotation of the drums in one direction winds on the up-haul ropes, causing an upward force at the deflector sheaves and thus, overcoming the friction of the tower sheave journals in their bearings, the unbalanced weight of suspending ropes and the inertia of the moving parts, lifts the span. All four of the operating drums are locked together by the connecting gearing,

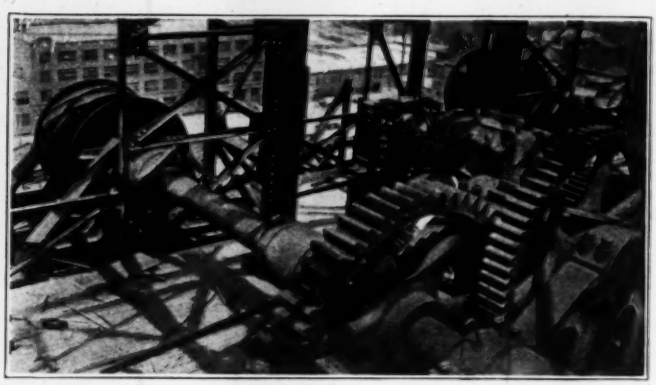

FIG. 2 PORTION OF THE OPERATING MACHINERY, BRIDGE NO. 458, PENNSYLVANIA LINES
300-hp. railway-type motor, steel driving gears with 20-deg. involute-cut teeth, and operating drums.

thus insuring the synchronous rotation of the sheaves and keeping the span at all times parallel to its original position. Fig. 2 illustrates the general scheme of operation.

To keep the span in proper alignment between the towers, vertical tracks are provided on the four tower legs adjacent to it, and on these tracks bear the rollers which hold the span both in transverse and longitudinal alignment. Wedge-shaped steel castings at the foot of each tower engage close-fitting mating castings on the span when the latter is two feet above its seat. Automatic locks hold the bridge down when once seated. Each lock consists of two cams locked together by two segmental gears, and counterweighted to swing toward each other and grip a link hanging from the floor beam of the lift span. The cams are supported by a steel-casting anchor

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For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

bolted to the piers, and the link, in descending, separates them and is in turn held by them when the end of the span is 1 in. above its final down position. Unlocking is accomplished by a foot-shaped bar, sliding vertically on the floor beam and connected by a wire rope to the lock lever in the operating house.

The counterweights of the Halsted St. bridge were made of cast iron, but considerable money has been saved on the Keithsburg bridge and on all later bridges by making them of concrete. Each weight is placed between two vertical steel members connected at the bottom by one or more laced struts and ending at the top in the equalizing devices to which the suspending ropes are attached.

A patented form of equalizer which makes the sixteen ropes receive their load from a single pin effects a very material saving in space over the types using straight horizontal bars and vertical links, and has the advantage of being less seriously affected in the event of failure of one of the ropes.

The third important bridge to be built was across the Willamette river at Hawthorne Ave., Portland, Ore. The lift span is 244 ft. long and lifts 116 ft. In this design, the machinery, located on the center of the span, is much more compact than in the Keithsburg bridge, all gears being mounted in the same frame instead of being supported on isolated bearings bolted to different parts of the steelwork. Operation is by two electric motors.

Electric power is far superior to any other for lift-bridge operation, as it makes possible niceties in control; direct-current motors are the most economical to use because of their high starting torque in proportion to their size.

While the Hawthorne Ave. bridge was under construction another lift bridge of entirely different character was being

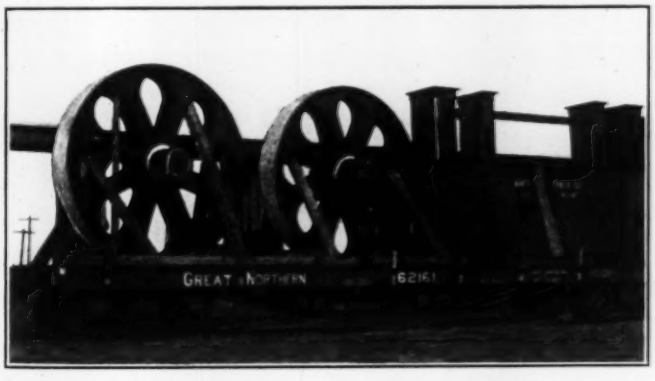

FIG. 3 TWO 12-FT. CAST-STEEL SHEAVES AND SUPPORTING GIRDER, MISSOURI RIVER BRIDGE AT MONDAK, MONT.
These sheaves weigh 7½ tons each and were built without any failures in casting.

designed. This was the 425-ft. span of the combined highway and railway bridge across the Missouri River at Kansas City. It consists of two decks, a fixed upper deck for highway and electric railway, and a lower deck for railway traffic, the hanger posts of the latter telescoping into the truss posts of the former as the lifting deck rises.

The live load coming on each lifting-deck hanger is carried by a pin into two saddle diaphrams in the upper deck truss. The dead load is carried into a pair of suspending ropes, which terminate in a counterweight after passing through the upper deck posts, over a deflector on the top chord, along the chord to the operating sheaves, and downward over another deflector. There are 15 panel points for each truss, and each point, except the two in the center, has one counterweight; the center points have two each, making 32 in all. There are two operating sheaves at each end of the bridge, and each pair is controlled by a motor and gear train near it. All suspending ropes pass over the four operating sheaves. The two sets of machinery, one at each end, are made to act together by means of two rope drives, one acting when the span is lifting, the other when it is lowered.

Each intermediate panel point of the lower deck is locked by a cam, and each end of the span is latched by a lock operated by a wire rope pulled by a segmental sheave in one of the machinery houses. All the hanger locks, 26 in number, and the two end locks, are operated by the same motor and gear train.

The Willamette river bridge of the Oregon-Washington Railroad and Navigation Co. is a combination of a simple lift

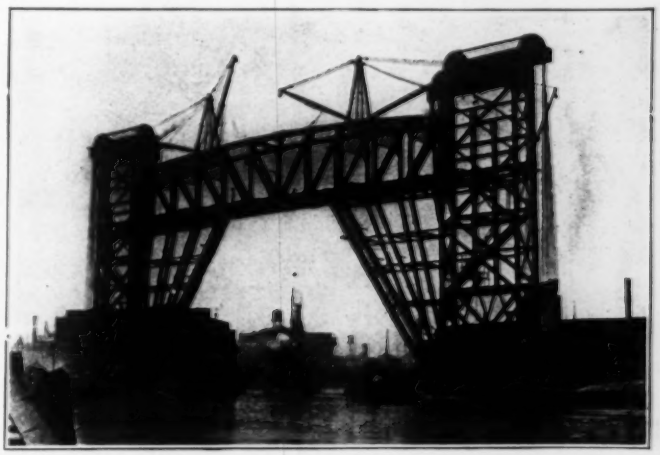

FIG. 4 LIFT SPAN, ERECTED POSITION, BRIDGE NO. 458, PENNSYLVANIA LINES
The falsework is carried entirely on the piers and spread out from each of the latter in a fan shape upward to the panel points of the trusses.

span and the lifting deck just described. This lift span is 211 ft. long, weighs 3,420,000 lb. and lifts 89 ft., while the lifting deck below it can lift independently for 46 ft., and will then lift with the span for 89 ft. The advantage of this arrangement is that the highway traffic on the upper deck is not interrupted for ordinary river traffic, as the upper deck must lift for high-masted vessels only. There are five or six full operations daily and ten times that number of lower-deck lifts.

The large tower sheaves of this bridge are of 14 ft. pitch diameter, carry sixteen 2¼-in. ropes, and are made of cast-steel rim segments bolted to a center of rolled-steel plates and cast-steel hub. The sheave bearings are provided with a system of wedges which permits the replacement of the phosphor-bronze bushings.

The reason for making these large sheaves of built-up plates and castings was because of the difficulty of getting single steel castings of adequate size. However, considerable progress was made in three years in the manufacture of large steel castings. The two sheaves in Fig. 3, of 12 ft. pitch diameter and weighing 7½ tons each, were built without any failures in casting. They were used in the Missouri River bridge at Mondak, Mont.

In the bridge designed for the Vladicaucase Railway for a crossing of the Don River near Rostoff, Russia, the drums are close together instead of being at the opposite ends of the main drive as is the case with the Pennsylvania bridge illustrated in Fig. 2. The advantage in this arrangement is one of economy. A large gear reduction is made at the drums and there is only one line of shafting across the bridge. With the reduction used, the shaft is considerably smaller

than one of the two required in former layouts. The gear frame is also much smaller.

One of the heaviest bridges so far designed is that over the south branch of the Chicago River, near 19th Street, known

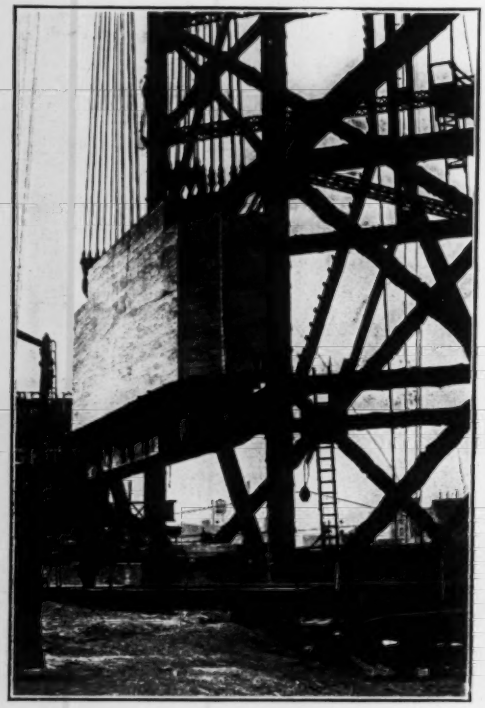

FIG. 5 COUNTERWEIGHT ON ITS FALSEWORK, BRIDGE NO. 458, PENNSYLVANIA LINES

800 tons of concrete are supported on girders which deliver the load to two inclined struts bearing on 6-in. pins carried in saddle castings.

as bridge No. 458 of the Pennsylvania Lines. This bridge carries the double track of the Pennsylvania Lines and will be used by the Pennsylvania, the Chicago & Alton, and the Pere Marquette. There is no *closed season* on the river at this point and the Government required that the lift span should be erected 120 ft. above the river, the normal clearance for the span when lifted. As it was not possible to drive any piling into the river bed because of the resulting obstruction to river traffic, the falsework had to be carried entirely on the piers and spread out from each of the latter in a fan shape upward to the panel points of the trusses, as represented in Fig. 4. There were no connecting struts between the two sets of falsework and the upper end of the leaning members of each set had therefore to be tied back to the towers with steel bars and plates.

To erect the span with 120 ft. vertical clearance would have meant that these top chords of the falsework must in each case be attached to the tower legs half-way between two of the horizontal struts of the bracing, and as this was not considered advisable because of the resulting bending in the tower legs, it was necessary to erect the span high enough to allow these chords to come in line with the next higher struts. This placed it at 130 ft. clearance instead of the 120 ft. required. All connections were made in holes from which the rivets had for the time being been omitted.

On account of the shape of the falsework the erection of this span upon it would have developed an uplift in the shoes of the far tower legs too great to be safely carried by the anchor bolts, and it was therefore decided to build the concrete counterweights in such a way that their weight would be carried into these shoes. This was done (see Fig. 5) by supporting the 800 tons of concrete at each tower on girders which delivered the load to two inclined struts bearing on 6-in. pins carried in saddle castings riveted into the columns just above the bases.

There was nothing unusual in the erection of the towers, the derricks being stepped up from story to story according to practice common for similar structures. The heaviest pieces in them are the bottom sections of vertical legs next to the lift span which weigh 42 tons each. The four sheaves on the top of each tower weigh 31 tons each and are the largest of their kind so far built. They are of 15 ft. pitch diameter and each pair carries sixteen 2¼-in. plow-steel ropes, each weighing with its sockets about 2000 lb.

The span erection was carried on with two A-frame derricks shown in Fig. 4, the work progressing on the two sides simul-

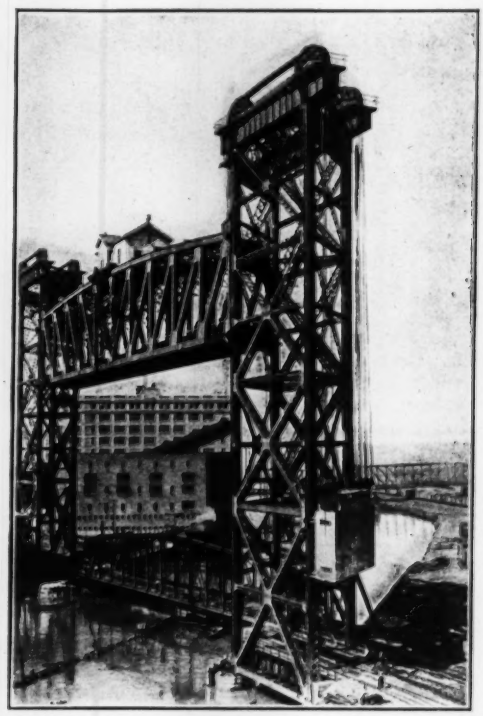

FIG. 6 BRIDGE NO. 458, PENNSYLVANIA LINES, AFTER REMOVAL OF FALSEWORK

The old swing span was kept in service until the upper structure was completed.

taneously. Only enough falsework to carry the end panel of the span was first set from the towers, and after the erection of these panels the derricks were moved from the towers to their first positions on the span, directly above the two sway frames nearest the ends. From here more falsework and more steel was erected and the derricks were again moved out. In Fig. 4 they are shown in their third and last positions as they stood to place the steel of the four center panels. To regulate the temporary camber to suit the erection of the last pieces of top chord, four hydraulic jacks were set beneath the bottom chord, immediately above the ends of the four last members of the falsework. Because of the eccentric loading on the towers there was bound to be some deflection of each tower toward the river, but calculations and measurements had been so carefully made that the two center pieces of bottom chord, 73 ft. 6 in. in length and weighing 36 tons each, when lowered into place fitted so exactly that the erection bolts could be entered without the use of drift pins. To get the last pieces of top chord in it was necessary to use the jacks.

Fig. 6 shows the bridge after the removal of the falsework and while the old swing span was still in service. This latter was partly under the new bridge, both open and closed, and as more than 300 trains use this crossing every day it was very important to take great care that nothing should be dropped from the span 100 ft. above. It is a matter for which the erecting contractor deserves congratulation that no accidents from this source occurred.

The new span is 272 ft. 9½ in. long, lifts 112 ft., and weighs 1600 tons. At present it will be lifted at the rate of 15,000 times a year, for it lies near enough to the water to be in the way of every tug, but the great majority of these operations will require lifts of only a few feet. In a few years it is planned to raise the grade at this crossing, and the design of the bridge was carried out with this idea in view. Aside from raising the floor systems in the towers, lowering one story of tower bracings, and raising the base castings of the lift-span shoes, no change in this bridge will be necessary to accomplish this end. The span is operated by two 300-hp. series motors drawing their power from a 120-cell storage battery.

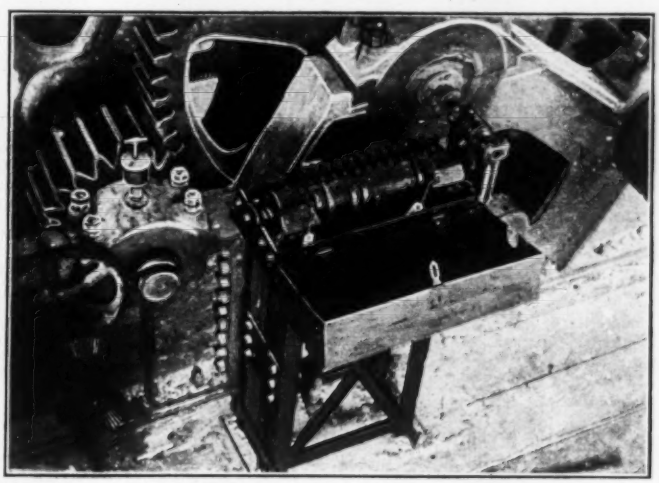

FIG. 7 ELECTRICAL INDICATOR AND LIMIT SWITCH, BRIDGE NO. 458, PENNSYLVANIA LINES

Indicates by lights in the operator's house several points in the height traveled by the span, and cuts the controller circuit near each limit of travel.

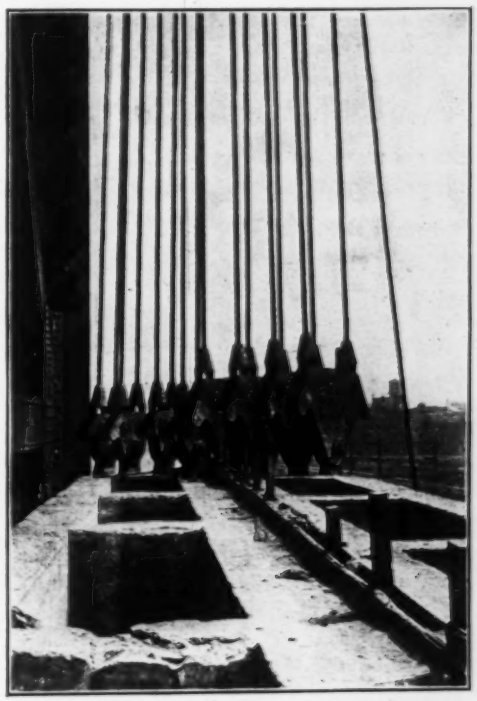

FIG. 8 EQUALIZER AND COUNTERWEIGHT, ERECTED POSITION, BRIDGE NO. 458, PENNSYLVANIA LINES

When the span is lowered into place the parts of the equalizer become more closely packed together.

The electrical indicator and limit switch in Fig. 7, connected to the drive by worm-gear reduction, indicates by lights in the operator's house several points in the height traveled by the span, and cuts the controller circuit near each limit of travel, thereby breaking the main circuit, stopping the motors, and applying the solenoid brakes. Details of the equalizer and counterweight are shown in Fig. 8. Waddell & Harrington were the designers, represented in the field by the writer, and the Pennsylvania Steel Company were the contractors for fabrication and erection of superstructure.

DISCUSSION OF CERTAIN PROBLEMS IN REGARD TO MARINE DIESEL OIL ENGINES

BY JOHN W. ANDERSON,[1] GROTON, CONN.

THE method of reversing used on the two-cycle engines is based on the fact that, in these engines, the spray and scavenger valves can be set right for running in the reverse direction by shifting the cams through a common angle. One camshaft running along the tops of the working cylinders operates all the valves; there is one cam for each spray and scavenger valve and the camshaft is shifted for reversing through an angle of 30 deg. The camshaft is shifted automatically by a slip coupling having a 30-deg. angle between the jaws, so that when the engine starts in the reverse direction, the crankshaft revolves 30 deg. before the camshaft starts, that is, when the timing becomes right for the new direction of rotation. The air starting valves are operated by two separate cams, one for ahead and one for astern, and the direction of rotation of the engine is determined by bringing into action the proper cam which in turn times the starting valve.

This automatic reversing mechanism fails to work satisfactorily when the engine is operated at low speeds, because then the engine does not turn exactly uniformly, and since the slip clutch is of the friction type, with jaws to limit the extreme travel to an angle of 30 deg., and since the camshaft and its parts have inertia of their own, this slip clutch fails to hold the camshaft in exact relation to the crankshaft. This upsets the timing of the valves, which in the case of the spray valve is important.

In the 1000-hp. engine installed in the single-screw submarine tender *Fulton* the shifting of the camshaft was made definite and positive by substituting, in place of the slip clutch, a sliding sleeve operated by a pneumatic cylinder under the control of the handling gear. The vertical shaft, which drives

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the camshaft from the crankshaft, is cut and the sliding sleeve connects the two parts; it slides on one of them on straight keys parallel to the longitudinal axis of the shaft, and on the other on spiral grooves, so that when the sleeve is moved along the axis of the vertical shaft the camshaft is twisted relatively to the crankshaft through the same angle of shifting used in the original design, namely, 30 deg.

To make the action still more positive, there is an automatic locking device on the pneumatic cylinder. It consists of a bar with two holes, connected to the lever operating the sleeve; corresponding to these holes there are two locking pins, one for each end of the pneumatic cylinder. The parts are so arranged that when the sleeve is in either extreme position, one of the locking pins fits into the proper hole in the locking bar and the parts are held securely in place.

When it is desired to reverse the engine, air is admitted by the handling gear to a piston on the locking pin holding the bar. This air pressure pulls the locking pin out, and when the pin is clear of the bar a port is uncovered leading to the pneumatic cylinder. The air pressure acting on the piston in the cylinder moves it to the other extreme position, setting the camshaft right for running in the opposite direction, and just as it reaches the extreme position it uncovers a port in the cylinder, admitting the air to the air starting valves on the working cylinders. Of course it is understood that when this gear reaches its new extreme position, the locking pin at that end of the cylinder registers with the hole in the bar and again locks the mechanism. The action is very simple and thoroughly foolproof and positive. This engine has been in service for some time now, and the reversing gear has amply lived up to expectations.

A similar method of reversing is used on the four-cycle engines, but unfortunately in this case it is necessary to have a separate camshaft for each kind of valve because of the different angles through which it is necessary to shift the cams in order to bring the timing right for the new direction of running. The engines are fitted with three camshafts, one for the spray valves, one for the inlet valves, and one for the exhaust valves. The air starting valves are operated by a single cam which is shifted by a separate mechanism to bring its timing right. The operation is pneumatic and the valves are controlled by plungers arranged radially around the single cam, in accordance with the proper sequence of cranks. All of the camshafts are shifted by means of a single pneumatic cylinder operating sliding sleeves similar to the one just described, except for the addition of a set of jaws on the camshaft which register with jaws in the sliding sleeve in its extreme positions and take the driving effort. The work of the spiral grooves is thus confined exclusively to shifting the camshaft. As in the two-cycle engines only a single cam is provided for each valve. This method of reversing has been applied to several engines and acts as satisfactorily in the case of the four-cycle engines as for the two-cycle.

The method of starting a Diesel engine which is almost universally used is by means of compressed air, and in most cases the air enters the working cylinders.

In starting, the air is ordinarily turned on for only a few seconds and in a few seconds more the engine can be brought right up to full power if desired. In fact, with a perfectly cold engine, the operation will be a great deal smoother under a moderate load immediately after starting than it will be at a very light load. This applies particularly at low speeds. For stationary engines which operate at full speed only, this condition is not encountered because the engine is brought up to full speed immediately after starting and the flywheel has inertia enough to keep the engine running smoothly even though ignitions are somewhat irregular.

In a marine engine the case is entirely different. Here it may be desired to start an engine slow ahead or astern, which, with a small, light, high-speed engine is difficult, unless a clutch between the engine and propeller permits the engine to be started up independently, warmed up, and then the clutch thrown in. The trouble in starting up when the engine is connected directly to the propeller is that in order to get the first ignition the fuel is turned well on, and when the first ignition does come there is enough energy in the combustion to overcome the inertia of the parts and drive the engine up to a much higher speed than is desired. With large, heavy engines this tendency is not nearly so marked and it is possible to get a slow, smooth start.

There are several ways to assist in getting a smooth start on a cold engine, and it is important to follow one of them in the case of large engines. One method is to heat the jacket water by turning steam in from an auxiliary boiler. In this way the cylinder walls can be warmed up to something approaching the working temperatures, and a smooth start is easily made. Another method, particularly useful in installations where very heavy fuels are used, is to start with a lighter fuel. By a lighter fuel is meant one that ignites readily and is more easily broken up so as to expose more surface to the heated air in the cylinder in the compression space, and thus give a quicker ignition. The solution to the problem of getting a good, smooth start consists essentially in having the temperature in the cylinders approximately the same as under working conditions and then injecting the fuel positively and regularly. Any method which does this will solve the problem.

Generally speaking, stationary engines and marine engines with clutches between the engine and propeller are fitted with starting valves on only half of the working cylinders. This means that while the engine is being turned over by starting air on part of the cylinders, the others are being warmed up by the compression, and even under very adverse conditions they soon reach such a temperature that ignition is obtained. In the case of reversing engines, the handling gear is sometimes modified to cause the starting air to be turned on and off the cylinders in groups.

The question of maneuvering is principally one of obtaining sufficient starting-air capacity, either by carrying a large number of flasks or—a much better way in the case of a large ship—by having an auxiliary compressor unit of good capacity. While the ship is maneuvering, the compressor unit is kept running all the time and pumps into the starting flasks. With such a provision an engine can be reversed repeatedly with only a very small starting-flask capacity.

In the case of small powers, it is much more convenient to use a clutch between the engine and propeller and employ a non-reversing engine which is kept running all the time.

The charge is often made against the Diesel engine that it is impossible to slow it down materially. This is true to a certain extent of the ordinary type of construction, but with the proper modifications any Diesel engine can be made to slow down and operate as readily at the lower speeds as at the higher. The solution of the problem consists in having a regular enough turning moment to keep the engine running fairly smoothly, and to obtain definite and regular ignitions in the cylinders. The case is much simpler for a large, heavy engine which has a big mass in the moving parts, and where there are a larger number of cylinders, say, at least six for a two-cycle engine and eight for a four-cycle engine, than it is for a small, light engine.

In the propulsion of a ship, the power drops off very rapidly as the revolutions are reduced, and therefore, at very low speeds, the power is so small that when divided up among all of the cylinders in the engine there is not enough fuel injected into each cylinder to give regular ignitions. This can be remedied in a large measure by cutting out half of the cylinders. The load per cylinder will then be more than doubled and the engine will run with very light loads at low revolutions.

Another method consists in the control of the spray-valve lift and timing by the operator. The control mechanism is so arranged that the timing and lift are changed at the same time. In some cases the valve is made to open at the same time under all settings and to close earlier, while in others it delays the time of opening by the same amount the time of closing is shortened. Both systems appear to work satisfactorily. When it is desired to slow the engine down, the fuel supply is reduced, the spray-valve lift reduced and the timing changed, and the spray-air pressure reduced somewhat. The combined effect of all these is to give regular ignitions in the cylinders, hence a smooth turning moment and good control over the engine. This method is much more preferable to cutting out some of the cylinders at reduced power, since it provides more impulses smaller in size and at closer intervals, which are all very vital points when running at very low speeds.

The advisability of fitting some sort of gear for controlling the timing and lift of the spray valve depends upon the type of engine and the place where it is going to be installed. Without such gear, an engine can be slowed down to about half speed without difficulty, hence for installations of small power in ships having a maximum speed of 10 knots or thereabouts it is unnecessary, because half speed means little more than steerageway. On the other hand, in the case of ships having a higher maximum speed such as 15 or 20 knots, it is very desirable to be able to slow the engine down to quarter speed or less, and then the installation of such a gear becomes almost a necessity. Under some circumstances, of course, it might be considered better to sacrifice maneuvering ability for the sake of simplification, but on engines of the size used on seagoing ships, the slight added complication due to this gear seems every bit worth while.

The question of lubrication is one that is dependent upon the type of engine. The gravity system is used successfully on large, open-frame, slow-speed engines, while on the small sizes, particularly where the crankcase is enclosed, a mechanical oiler is often used with leads to separate bearings or else a system of forced lubrication. There is one difficulty with the gravity lubrication and the mechanical oiler, and that is that there are many parts and pipes to consider, and each pipe or lead requires a certain amount of individual attention in order to see that the proper amount of oil is being supplied to that particular part. Furthermore, with these systems only just enough oil with a slight margin is provided to cover the necessary requirements of the bearing.

The big advantage of the forced-lubrication system is that a good surplus is supplied to each bearing at all times and distribution of the oil is secured by the proportions of the various passages, and hence requires no attention on the part of the operator other than to make sure that the main supply to the engine is kept up. Of course the various passages must be kept clear and open, but this is a matter that can be readily attended to during the overhauling period, and there is very little tendency for the oil to plug up the passages during operation.

There is one thing in connection with forced lubrication that is extremely important and requires constant watchfulness on the part of the operator, and that is the question of salt-water leaks into the lubricating oil. Any leak into the crankcase, no matter how small, forms an undesirable mixture with the lubricating oil, and at moderate temperatures creates a deposit which will quickly plug up the passages. If special precautions are taken against the leakage of the salt water into the oil, and the condition of the oil is watched carefully at all times, there is little chance for difficulty in this direction. From every other standpoint forced lubrication has the advantage over other methods. The proof of this is best shown by the increasing adoption of this system on engines of all types and sizes.

With an open-frame engine and using special precautions so that lubricating oil from the working cylinders does not drip into the crankcase, the oil does not become foul except after long service, but with the closed-crankcase trunk-piston engine the lubricating oil soon becomes fouled with finely divided carbon particles. After a time the oil turns very black and viscous and tends to clog the oil passages. This requires as much as 3000 hours' running in some cases, while in others this condition obtains in a few hundred hours. It is understood, of course, that oil is added from time to time to make up for the losses, but the system is not cleaned out and the whole supply replenished in all this time. As this condition of the oil is approached the danger of bearing troubles increases, and if it can be avoided the oil ought never to be allowed to get into such a condition.

Most of the carbon particles are removed by filtering, and the filtered product approaches the original in all its properties except that it is darker, due to the presence of the particles, which were not removed by filtering. The centrifugal process of clarifying is even better than filtering and removes a larger proportion of the carbon particles.

To attempt to filter or clarify the oil each time it is circulated through the engine would imply the addition of too much apparatus to take care of such a quantity of oil, and, fortunately, it is unnecessary. The best way is to drain out the system at regular intervals, depending upon the type of engine and the conditions of the service, and fill up with fresh oil. The fouled oil can be filtered at leisure and kept for future use.

The Diesel-engine industry is still so young that the question of how large an engine can be built is one that cannot readily be answered at this time. Practically all of the engines in service today are of small and moderate power as compared with certain steam plants, but, on the other hand, big strides have been made in the last few years in the development of large units.

In view of what has already been done and the experimental work that has been undertaken by so many firms, it is undoubtedly only a question of time when Diesel-engine power will be available for all except the very fastest liners and warships.

The vibration produced by an engine depends largely upon the number of cylinders and upon their arrangement. In commercial work, generally speaking, the speed is slow enough and the hull heavy enough so that the matter is not one of great importance; but in the case of a high-speed engine in a light hull, it is absolutely necessary that the engine be properly balanced.

For commercial work, many four-cylinder, four-cycle engines have been built, and these engines are very badly out of balance due to arranging the cranks all in one plane to get the best turning moment. But, as already stated, where these engines have been installed no serious difficulty has resulted,

due undoubtedly to the relatively low revolutions and the small size of the engine as compared with the hull.

If good balance is desired, it is necessary to use six or eight cylinders, which can be made to give the best turning moment and a good balance at the same time. The only thing that interferes with giving these engines a perfect balance is the air-compressor cylinders, but the reciprocating parts of these compressor cylinders are comparatively light, and hence do not cause any serious difficulty. In the case of crosshead engines it is oftentimes convenient to drive the compressors by beams and links from the crossheads. On a six-cylinder, four-cycle engine, for instance, there might be three compressors driven from three of the cranks, or on a six-cylinder, two-cycle engine three compressors would be driven from three of the crossheads and three scavenger pumps from the other three, so that a practically perfect balance would be obtained.

The usual method for the fuel system is to carry the main supply of fuel in the double bottom or in tanks in parts of the ship that are not ordinarily otherwise used, and then provide pumps for pumping it into gravity tanks placed well up in the engine room, so that the fuel can flow by gravity from the tanks to the engines. The tanks are made large enough to hold at least several hours' supply, and oftentimes a whole day's supply, so that the fuel has plenty of time to settle, and any sediment or water will collect at the bottom of the tank, where it may be drained off. It is very necessary that the fuel supply to the engine be perfectly clean. Very small particles of dirt or foreign matter will stick in the valves on the fuel pumps on the engine and cause no end of trouble. There is only one way to avoid getting this dirt into the engine, and that is to filter the fuel properly. The filter is sometimes placed between the gravity tank and the engine, and is sometimes combined with the gravity tank. In case the gravity tank is of small capacity, it is generally placed on the discharge side of the pump which pumps the fuel from the main tanks to the gravity tank.

The arrangement of the exhaust piping depends upon the type of the boat and the conditions of the installation. In the case of small boats, where the water line is more or less fixed and very little rough water is encountered, an underwater exhaust works out very satisfactorily, but in the case of large ships, the exhaust must be carried up a stack. In twin-screw boats it is essential that the exhaust from each engine be kept separate so that it can be watched by the operators. One of the simplest methods of detecting faulty operation in a Diesel engine is to watch the exhaust. The least sign of smoke is a sign of poor combustion and should be investigated at once.

Many varieties of muffler are used. The main idea of all of them is to break up the pulsations in the flow of the gases and give a steady flow. Where there is plenty of space and weight available, a big expansion chamber serves fairly well, but it is much better to reduce the size and use baffle plates. One of the best types is one in which the gases enter a cylindrical chamber tangentially at the circumference and escape at the center, or vice versa. Cooling the gases by turning the cooling water from the engine into the exhaust pipe helps too, but is not used except in some special cases. If there is very much sulphur in the fuel, water combines with the products of combustion and forms sulphuric acid, which will in time destroy the exhaust piping. If, however, the entire quantity of the cooling water passing through the engine is turned into the exhaust, the mixture is so dilute that there is little danger of trouble.

The piping itself must be jacketed or lagged, and due allowance must be made for expansion. Water jacketing is, in most cases, more satisfactory, but it adds to the complication and cost of the system, and for that reason is oftentimes avoided and the pipes are lagged.

The question of cooling the various parts of a Diesel engine is an important one, but as far as the fixed parts are concerned the problem is simple for all ordinary sizes of engines It is only necessary to provide for the proper flow of the cooling water, avoiding all pockets and dead areas. In the case of nearly all two-cycle engines and in four-cycle engines of quite moderate size, it is necessary in addition to cool the working piston, and herein lies a real problem. There is no exact dead line below which cooling is unnecessary and above which cooling is necessary, as a great deal depends upon the conditions of operation; that is, a high-speed engine designed to be driven at a heavy overload might require cooling, while the same engine driven at a lower speed and moderate power would operate perfectly satisfactorily with uncooled pistons. It is simply a question of carrying away the heat absorbed by the top of the piston. If it can be carried off fast enough through the cylinder walls to keep the center of the piston head from getting too hot, then the pistons do not need to be cooled, but if this is not so, then the extra heat must be absorbed by the circulation of a cooling medium through the piston. In general, it may be said that two-cycle engines developing 50 b.hp. or more per cylinder, and four-cycle engines developing 150 b.hp. or more per cylinder, are better off with cooled pistons.

The difficulties in the way of successfully cooling the piston are best shown by the variety of substances used and by the various devices employed to carry the substance to and from the piston. The simplest method is to employ a jet of air, but this is not very effective and can be used only where the cooling effect required is very slight. The other three substances employed to any extent are lubricating oil, fresh water and salt water. Lubricating oil has the distinct disadvantage that its specific heat is only about 0.4 of that of water, and hence about $2\frac{1}{2}$ times as much must be circulated to carry off the same amount of heat within the same temperature limits. In addition, oil does not absorb heat from, or give heat to, a metallic surface as readily as does water. The one advantage of oil is that in case of any leakage inside of the crankcase, it mixes with the other lubricating oil and does not cause any damage.

In view of all this, it is readily understood why lubricating oil is used only in special cases where certain conditions make the advantages more than outweigh the disadvantages.

For commercial work it is safe to say that the choice lies between fresh and salt water. Fresh water requires an additional system, including tank, pump, cooler and piping, but it is not so corrosive, not so destructive to the packing in the joints of the system, not dangerous as regards deposits in the piston, and in case of leakage into the lubricating oil there is not the danger of damage to bearings. When salt water is used with proper precautions, most of the advantages of fresh water disappear; but it is a question as to how far these precautions can be successfully carried out under every-day working conditions. Both fresh and salt water will undoubtedly be used for some time to come until enough experience is gained with both systems to finally settle the matter either one way or the other, or it may be that fresh water will be used for high-grade installations, and salt water where first cost and simplicity are of prime importance.

To carry the liquid to and from the piston there are three general systems, but the details for any one system are varied greatly by the various engine builders or by the same builder

on different engines. One system is to combine the cooling with the lubrication system, but this, of course, is applicable only in case lubricating oil is used for cooling. The general scheme is to supply the oil to the main bearings, from whence it passes through the hollow crankshaft to the crankpin bearings and up the connecting rods to the wrist pins, thence through pipes or passages in the piston to the head and back again through a pipe or passage to some point near the bottom of the piston from where it can drain directly into the crankpit. A certain amount of oil leaks out at the bearings, and this serves to lubricate them.

A second system is to use jointed swinging pipes, and a third system, telescopic pipes. Both inlet and outlet pipes can be, and are generally, used so that any liquid desired can be employed for the cooling medium. The swinging pipes are suitable for slow-speed engines only, as at high speeds the inertia forces are very large and it is troublesome to take care of them properly. Moreover, the passage for the liquid must by the nature of the case have several bends and turns, and at high revolutions the inertia forces produce extremely high pressures, making it very difficult to keep the joints of the system tight.

There is one principle that must be followed in the design of swinging pipes for even moderate speeds, and that is to keep the bearings at the joints of the pipes entirely independent of the stuffing boxes, or, in other words, the piping for carrying the liquid, and the strength members for taking the inertia forces must each do its own work, although they are fastened together and are a part of each other. The great trouble with this system is to keep it tight at the joints, and it is only by careful designing along the lines stated that successful results can be obtained. In case water is used for a cooling medium, the lubrication of the bearings at the joints becomes important, but with forced lubrication there is generally enough oil flying around in the crankcase to take care of this if pockets, connected to the bearings, are provided for catching it.

Telescopic pipes are adaptable to both high- and low-speed engines. All parts are moving in line with the cylinder axis, and taking care of the inertia forces is much simpler than with the swinging links. Moreover, there are fewer turns in the passages for the cooling medium, and, as a general thing, air chambers can be placed so as to effectively care for the surges in the cooling liquids. An air chamber on the suction side is a necessity, but on the discharge side it may be dispensed with provided the discharge pipes are of generous size. It is good practice to put an open-end pipe discharging into a funnel, with proper provision against splashing, on the discharge line so that the cooling fluid coming from the piston can be actually seen by the operator. A certain amount of flexibility in the telescopic pipes is desirable, in order to remedy any slight looseness of the piston, or of the crosshead in its guide, or any slight misalignment. One method of accomplishing this is to provide a double pipe, one inside of the other. The inside pipe is fastened at one end to the piston or crosshead and at the other to the outside pipe. The outside pipe is guided in the part fixed to the engine frame. Here again the most troublesome part is the packing, but it is like packing the piston rod of an engine, and, as might be expected, the most satisfactory packing is of the labyrinth type, with provision for self-adjustment to the pipe so that it fits snugly under all conditions.

THE RELATIVE CORROSION OF CAST-IRON, WROUGHT-IRON AND STEEL PIPE IN HOUSE DRAINAGE SYSTEMS

By WM. PAUL GERHARD,[1] NEW YORK, N. Y.

A SPECIAL investigation was made in the summer of 1918 in New York City, with a view of bringing out facts regarding the deterioration by corrosion, and incidentally other characteristics, of cast-iron, wrought-iron and steel pipe as used in the drainage of buildings.

The plumbing of buildings comprises two distinct piping systems, namely, the *drainage* system (composed of sewer, drain, soil, waste and vent lines) and the *supply* system (composed of hot, cold and circulation pipes). The investigation was confined to the drainage and vent system.

The following kinds of pipes are used as materials for such drainage systems: standard or light and extra heavy cast-iron soil pipe (in 5-ft. lengths); light tarred cast-iron gas pipe (in 9-ft. lengths); standard-weight wrought-iron and steel pipe (in lengths of about 20 ft.), and finally extra heavy wrought-iron and steel pipe, both the steel and wrought iron being either black, asphalted or galvanized.

In the oldest plumbing installations standard cast-iron soil pipe was usually tar-coated or painted as a protection against corrosion. After about 1881 such pipe was not permitted to be used by municipal plumbing regulations, and extra heavy pipe took its place. Even this pipe was liable to have sand or blow holes, and its lead-calked joint was rarely permanent, as it was affected by extremes in temperatures.

These objections led to the introduction, in about 1881, of screw-jointed welded pipe with recessed drainage fittings, the late Mr. C. W. Durham, Mem.Am.Soc.C.E. having originated it. This system soon became the favorite one with the rapid growth of the skyscraper buildings in large cities. The earlier systems were of wrought iron, but since about 1890 steel pipe has also come into extended use.

In course of time severe corrosion occurred in some Durham drainage systems, and this led the manufacturers of cast-iron pipe to claim that both wrought-iron and steel pipe were not materials suitable for house drainage.

Great pains were taken in the investigation to distinguish between genuine wrought-iron and steel pipe, and the conclusion was reached that there was a vast difference in the corrosion of the two materials, and that steel pipe proved in actual service to be much inferior to the wrought-iron pipe.

The investigation involved the inspection of 78 buildings along both sides of Broadway, from Bowling Green (downtown) to 42nd Street. It included many modern office buildings and skyscrapers, also a few hotels and one large department store. The newer buildings, those less than 5 years old, were omitted from consideration, it being assumed that the corrosion of the pipes, if any, had not advanced suffi-

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ciently to give much information of value. The roof vent pipes of the buildings were selected because these formed almost the only parts of the drainage system, of which the interior could be freely examined. An attempt, however, was made to gain information regarding the main drain lines in the cellars.

The oldest buildings were found to have cast-iron drainage systems, but in the later buildings, and chiefly in those over ten stories in height, the screw-jointed system prevailed, doubtless because of its important advantages over the former.

Samples from over 500 wrought-iron and steel roof vents were taken for analysis to determine the material. The method

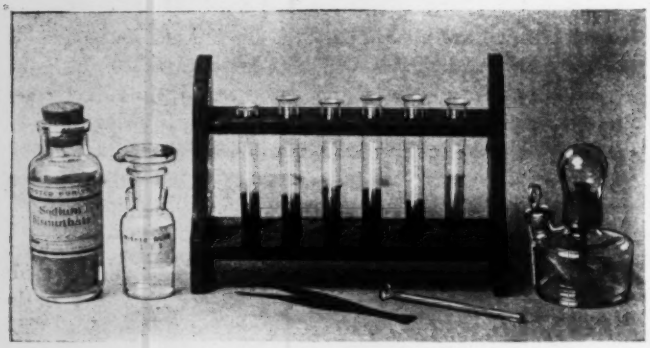

FIG. 1 MANGANESE TESTING OUTFIT

of testing was by the "manganese test." Small chips from the roof pipes were cut off by hammer and chisel, paint and galvanizing having first been removed with a file. The testing outfit used was a very simple one (see Fig. 1), and comprised a number of glass test tubes, with tube rack, a bottle of diluted nitric acid, a bottle of sodium bismuthate, an alcohol lamp, glass ladle and steel pincers. When the sample tested was steel, a decided pink color showed in the test tube, whereas if it was wrought iron, a brownish residue showed in the bottom of the tube. In numerous cases the chemical test was supplemented by a fracture test, showing the characteristic fibrous appear-

FIG. 2 CAST-IRON PIPE SHOWING TYPICAL CORROSION RESULTING IN EVEN POCKMARKING OR SHALLOW PITTING

ance of the break, if the material tested was wrought iron, and a bright crystalline appearance if the pipe was of steel. Doubtful cases were further investigated by referring larger samples from the roof pipes for microscopical examination to Prof. W. Campbell, of the Metallurgical Department, and for chemical analysis to Dr. Fales, of the Department of Chemistry, of Columbia University. Numerous photographs were also taken as a further record of conditions found.[1]

Two quite distinct forms of rusting or corrosion were observed, namely, pitting or pockmarking, and scaling or flaking. Both the wrought-iron and the cast-iron pipes were found to be evenly pitted to a comparatively shallow depth, thus reducing the pipe thickness but slightly (see Figs. 2 and 3). Many of the older steel pipes showed a characteristic and often aggravated form of scaling (see Fig. 4). When removed, the flakes often leave but a thin outer crust of the original metal; the scaling had a tendency to fall off by its own weight and to choke the vent pipes at angles or bends in the line.

While the genuine wrought-iron pipes made an excellent showing, the steel vents in service more than 20 years showed in nearly all cases a very bad deterioration.

As regards the drains and house sewers of welded pipe, a number of instances were recorded of pipes having become corroded, but only in a few cases could samples of the removed pipes be obtained for analysis. Assuming, however, the corrosive conditions to be no more severe in the drain pipes than in the roof vents, the drains would naturally last longer because of their larger sizes, which involve a greater wall thickness of the pipe. Concerning cast-iron drains, a few buildings still had the old light-weight pipes, and these were found without exception to be in bad shape, having leaky joints and sometimes holes, due either to corrosion or to the cutting of the pipes for the removal of stoppages, which were patched up with clamped bands. Where the house drains were of extra heavy cast iron, numerous instances of leaky joints were dis-

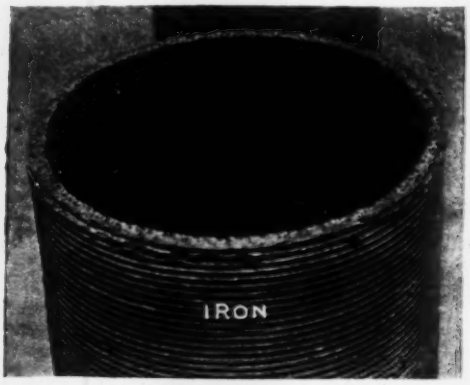

FIG. 3 WROUGHT-IRON PIPE SHOWING TYPICAL CORROSION RESULTING IN EVEN POCKMARKING OR SHALLOW PITTING

covered. This well-known defect of the calked joint in plumbers' pipe is particularly frequent where large volumes of hot waste water pass through the pipes, and also where steam exhaust, drip and boiler blow-off pipes are tapped into the house sewers. Municipal rules have for many years forbidden this practice, but it is still kept up, usually so after a building has been passed by the plumbing inspector.

The conclusions reached by the investigation may be summed up as follows:

1 Cast-iron pipe is a satisfactory material for house drainage purposes, many cast-iron roof vents showing up even more favorably as regards corrosion than had been anticipated, but the principal objectionable feature remains, i. e., the unsafety and unreliability of the calked joint, which can never be depended upon to be a permanently tight joint, because of expansion and contraction. A further objection to cast-iron drain and soil-pipe systems is that owing to the pipes being only five feet in length a much larger number of joints must be made, involving more labor in erecting and supporting the pipe stacks, and also the multiplied danger from leaky joints.

[1] Typical halftone illustrations appear in the complete paper.

2 The screw joint in welded pipe is much superior to the calked joint.

3 Steel pipe is much inferior to both cast-iron and wrought-iron pipe when exposed to corrosion. Galvanizing adds to the life of the pipe, but the coating does not adhere as well to steel pipes as to wrought-iron pipes. The rust resistance of the base metal is, however, of far greater importance than the preservative coating.

4 Ample evidence was obtained in this investigation to warrant the opinion that genuine wrought-iron pipe is a far more durable material for house drains and vents than steel pipe.

5 In recent years there has been a widespread substitution of the cheaper steel pipe where wrought-iron pipe was called for in the specifications. Then, again, engineers' and architects' specifications often make no discrimination between genuine wrought-iron and mild-steel pipe, and this is equally true of plumbing regulations.

6 Important municipal and governmental buildings, as well as those erected by private enterprise, all of which are expected to last from 50 to 100 years, should have all their important installations, and in particular those parts which are inaccessible after the building is completed, composed of materials having a corresponding duration of life.

In conclusion, one fact should be mentioned which may have contributed to the confusion as to wrought-iron and steel pipe, and that is that manufacturers and dealers have introduced the term *wrought pipe* for the purpose of designating steel pipe, when there appears to be no good reason why the material should not be called by its true name, viz., steel pipe.

This investigation as to the life of cast-iron, wrought-iron and steel pipe was in charge of the writer, and he personally inspected all buildings, witnessed all chemical tests, and selected the typical vents which were photographed. The work was undertaken at the suggestion of the A. M. Byers Company, manufacturers of genuine wrought-iron pipe, of Pittsburgh, Pa.

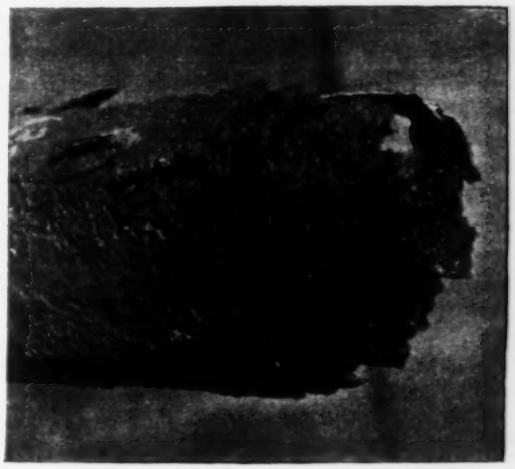

FIG. 4 STEEL PIPE SHOWING AGGRAVATED BUT TYPICAL CORROSION RESULTING IN FLAKING OR SCALING

WEIGHTS AND MEASURES OF LATIN AMERICA

BY FREDERICK A. HALSEY,[1] NEW YORK, N. Y.

THE inquiry of which this paper is a report was conducted through a questionnaire of which about 500 copies were distributed throughout South and Central America and the West Indies. In order to secure representative and impartial distribution, outside agencies were enlisted in the work, the printed blanks being sent to their branches and correspondents by the National City Bank, the United Fruit Company, W. R. Grace and Company, and the Hill Publishing Company. Additional copies were sent out by the author to names taken from a commercial list obtained from the United Fruit Company and to United States consuls.

The questionnaire as drawn up in English will be found in the Appendix, together with the form letter which accompanied it. The actual printed forms sent out were translated into Spanish and Portuguese, in which languages most of the replies came back. The information given herein is not, however, limited to that obtained through the questionnaires as various citations in the text point out. In all cases, quotations without names attached are from the questionnaires.

SPANISH AND PORTUGUESE WEIGHTS AND MEASURES

As many readers are not acquainted with Spanish weights and measures, tables of the more common units and their relations are here given. The translation of the names is almost self-apparent, but the following are given:

Onza	Ounce	Pulgada	Inch
Libra	Pound	Pie	Foot
Tonelada	Ton	Vara	Yard
Cuartillo	Quart		

The Portuguese names are so similar that their meanings will be apparent.

SPANISH WEIGHTS AND MEASURES

WEIGHT

16 onzas	= 1	libra
25 libras	= 1	arroba
4 arrobas	= 1	quintal
20 quintales	= 1	tonelada

DRY MEASURE

4 cuartillos	= 1	celemin
12 celemins	= 1	fanega
12 fanegas	= 1	cahiz

LIQUID MEASURE

4 cuartillos	= 1	azumbre
8 azumbres	= 1	cantara
16 cantaras	= 1	moyo

LENGTH

12 pulgadas	= 1	pie
3 pies	= 1	vara

UNIFICATION OF ENGLISH AND SPANISH WEIGHTS AND MEASURES

With slight differences in the values of the units, this system is substantially identical with our own. With suitable foresight and effort the two might have been unified long ago.

[1] Commissioner, American Institute of Weights and Measures. Mem. Am.Soc.M.E.

Abstract of report prepared for the American Institute of Weights and Measures. For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

The chief difficulty in the adoption of the metric system in Latin America has been and is the psychological difficulty—that is, learning to think or vizualize values in strange units. In this sense the difficulty of adopting the English values of the units would have been nil for there would have been too little change in values to cause confusion of thought, while in names there would have been none.

Meanwhile the still greater difficulty in our own case—the physical difficulty due to the anchorage of units in standardized manufacture—was and is absent in Latin America where but little manufacturing is done. The difficulties in the way of adopting the English values of the units thus were and are trifling in comparison with those in the way of adopting the metric units. Moreover, the process would have been one of subtraction, two sets of values being reduced to one, and, internationally considered, several sets of values reduced to one, for the Spanish units have slight and annoying differences of value in different countries. The "adoption" of the metric system, on the other hand, has been one of addition, another set of units being added to those already existing.

The ease with which the English values of the units might have been adopted is shown by these reports of the progress they have made. With no trace of compulsion or even governmental recognition, they have come into large use by the operation of the forces of trade and commerce and by simple acceptance, whereas the metric units have nowhere made progress except by compulsion.

The remaining question is: Is it too late? Except for units for land measure, which, once established, should be let alone, I think not, for conditions have not materially changed in Latin America. It must be apparent there, as this inquiry makes it here, that the attempt to adopt the metric system is a failure. The weights and measures of Latin America are in a state of chaos, for which a remedy is sorely needed. Were they to dismiss the intruder and retain the old historic names with changes in values which are so slight as to be inappreciable for most purposes, Pan-Americanism in this important field would become an accomplished fact, and the unification of the weights and measures of North and South America with those of the British Empire would be within sight.

It is especially to be noted that until about the beginning of the present century there were few, if any, compulsory metric laws in Spanish America. The system had been "adopted" in many of those countries as the official system, and used chiefly for customs purposes and railway tariffs, but the people continued to use the old measures without molestation. The change in the intervening years is due to German influence and for German purposes. If, as seems probable, German influence in Spanish America is to suffer an eclipse, is it too much to hope that the future may see the unification of the weights and measures of North and South America and the British Empire on the foundation of the system which, in its basic and historic features, is common to all?

Meanwhile we have an important lesson to learn from Latin America. A glance through these reports will reveal the common practice of selling grain and other farm products at wholesale by *weight*, the arroba and the quintal being favorite units.

Our clumsy efforts to connect the bushel and pound through conversion factors are the cause of much confusion[1] which would disappear were we to copy this practice, and, incidentally, deprive the metricites of a false argument which is on all their lips. and which the unthinking know no better than to accept. The unit for this purpose should be the quintal of 100 lb.—a name which is preferable to hundredweight as it avoids confusion with the British hundredweight of 112 lb.

[1] It should be noted that the adoption of the metric system would not do away with this confusion since wheat, corn, rye, etc., do not weigh the same per decaliter any more than they do per bushel. The sale of these and similar commodities by *weight* is the simple and sufficient method of abolishing all the confusion now experienced in this branch of trade.

General Analysis of Results

The effort to learn the relative usage of the different systems has not been successful. When one return gives exclusive use of the metric system for a given purpose and another exclusive use of the Spanish system for the same purpose, discrimination is impossible. The thing here proven is that the claim that Latin America is metric is false, as are all arguments based upon it. In particular it should be noted that the order in which the units are herein named has no significance.

In but one of the countries investigated (Uruguay) can the metric system be said to be adopted for domestic trade, while there we find an authorized official exception in the case of real estate, a. we find other exceptions in the cases of wearing apparel, industry, and navigation. Nevertheless, in twelve of these twenty countries, according to a report on The Metric System in Export Trade by the Director of the Bureau of Standards, the metric system is "obligatory."[1]

In ten of these countries (apart from the railroads and other fields under immediate government control) the metric system has made almost no impression. (Nicaragua, Guatemala, Spanish Honduras, Cuba, Panama, Colombia, Porto Rico,[2] San Salvador, Ecuador, and Costa Rica.

Of these ten countries, according to the above report, the metric system is "obligatory" in seven. In five of them (Cuba, Colombia, Porto Rico, Panama, and Spanish Honduras) the English units are used far more than the metric, having largely supplanted all others, although in three of them, according to this same report, the metric system is "obligatory." Not only has the English pound come into large use, but the arroba and quintal have been adjusted in value to make them equal to 25 and 100 English pounds, respectively. In substantially all of the countries investigated the English inch is used for mechanical purposes, as the English nautical units are used for navigation and sea shipments. That most derided of English units—the nautical mile—is used by all countries that sail the seas and they use no other. The kilometer is an unknown measure at sea.

In all countries the impression made is in direct relation to the severity of the laws, of which we have the climax in Uruguay, with Venezuela and Argentina not far behind. In all cases the movement was begun with mild laws under the impression that the adoption of the system was a simple and easy thing to bring about. Such laws failing, more drastic ones followed, but even these have been but partially effective. The greatest progress has been made in the field of domestic retail trade, in which weights and measures are under the immediate eye of officers of the law.

It is this field which comes under the observation of tourists. One may tour through, or, for that matter, live in a country for many years, in many walks of life, and experience but

[1] See The Metric System in Export Trade by the Director of the Bureau of Standards, page 17; Senate Document No. 241, Government Printing Office, 1916.

[2] Porto Rico is always claimed to be metric by the advocates of the metric system. But, according to Mr. Fred R. Drake, Chairman Executive Committee, American Metric Association, "The meter, liter and gram continue to prove most satisfactory in official and general use in the Philippine Islands, *Porto Rico* and other United States possessions."

little contact with weights and measures outside the field of retail trade, and we thus see why the reports of tourists are more favorable to the metric system than the facts justify, as we also see why the observations of tourists, in a comprehensive sense, have very limited value.

The further we get from the field of retail trade, the less is the system used. In this field the progress is chiefly with units of weight and capacity, the measure of length for the sale of drygoods being commonly the vara, while imported wearing apparel of all kinds is commonly sold by the units of the country of its origin, by the inch at least as much as the centimeter, and domestic products are frequently made to numbered sizes, of which the relation to any system of units is not apparent. They are not metric.

In primary or wholesale markets the old measures prevail, although these, in some cases, have been adjusted in value to make them even multiples of English basic units. We have here perfect examples of the simple process of unification of English and Spanish measures which, with proper encouragement, might by this time have become substantially universal.

Lumber and timber are almost universally sawn to the inch, although frequently mixed with the vara or the meter for length, and the square and cubic meter as sales units, prices being made at so much per square or cubic meter for one-inch boards.

In the mechanical trades tailors and seamstresses use all three systems, as do stone and brick masons, while carpenters commonly use the pulgada or inch. In machine shops both English and metric units are used, depending chiefly on the country of origin of the machines they have to repair. The inch is predominant.

In this connection we have the report of the Cleveland Twist Drill Company that shipments of their tools to South America are "95 per cent to 100 per cent English," and of the Detroit Twist Drill Company that "All of our South American customers use more English sizes than metric." Needless to say, English-sized twist drills are bought in order to make English-sized holes, for they will make no other.

In ship and boat building, also, the English units find large use, while in mining and smelting we find a miscellaneous mixture of all three systems.

The persistence of old units is most pronounced in the measurement of land. When units of measure are once anchored in titles to real estate, they are there to stay. Of this we have perfect examples in the use of the French arpent in Louisiana and the Spanish vara in Texas, in which states those units are today the common units of land measure. Another example is found in France, where, in some sections, the old units of land measure are still predominant.

When outlying districts are incorporated within city limits, parcels of land are much reduced in size and smaller units come in. This gives an opportunity for the introduction of the metric system, but with the result that, in the older portions of the town, the old units are used, while in the newer portions we find the new ones.

Similarly, initial surveys of the *hinterland* give an opportunity for the use of new units, but again with the result that the older portions of the country are measured in one set of units and the newer in another.

In Uruguay, where the laws are more severe and more rigidly enforced than in any other country, it has been found necessary to authorize the use of old units for the measurement of land (see Uruguay below), while in other countries the laws, in this application, are quietly ignored. This is the more significant because all transfers of real estate, as matters of public record, come before the eyes of officers of the law. In other countries, again, the purchase and sale are made in Spanish units and the day is then saved by inserting metric equivalents in the documents of record.

In marine measurements and sea shipments the English system is used everywhere, although mixed with metric units, especially for inland navigation.

Classified in another way, the most-used metric units are those of capacity. Next come those of weight, and, trailing far in the rear, those of length and their correlatives of area. This is in accordance with a law which long ago made itself apparent.

The Reason Why Compulsory Metric Laws Fail

A few words in explanation of the failure of even drastic laws for the adoption of the metric system are here appropriate. Such laws fail because established and harmless practice cannot, except in a technical sense, be made a crime. Fancy an American grocer arrested, haled to court, fined, and even sent to jail for selling sugar by the pound—a thing that has been done since the Pilgrim fathers landed at Plymouth Rock. And yet this is exactly what they do in Uruguay. Place a meter and a yardstick alongside. They differ in value by about 10 per cent. Is it conceivable that selling by one can be made a virtue and by the other a crime? Fancy an American jury convicting a merchant of a crime for selling drygoods by the yard! And yet this is precisely the meaning of compulsory laws.

It is a truism of law that excessive penalties cannot be enforced and so defeat themselves, and is it not clear that compulsory metric laws in any country in which the people have rights are unenforceable, and that the more drastic they are, the more unenforceable they become?

Theories Disproven

On its face, this Report sets forth a volume of facts regarding the weights and measures of Latin America, but, in addition to this, it disproves many theories.

The first theory is that it is an easy and simple matter for a country to change its system of weights and measures. Here we have the results of twenty attempts to bring about this change, most of which date from about the middle of the last century. In most of them the result has been grotesque failure, while in none has the attempt to retire old units been successful.

It is on this theory that the entire metric case is based. Once one has accepted the idea that a country may easily change its weights and measures, it is a short step to the conclusion that those who have tried it have succeeded, and then another short step to the conclusion that we can succeed. The question at issue is one not of belief but of fact. With 20 failures after, in most cases, more than half a century of effort, the fact is proven.

The second theory is that the adoption of the metric system does away with confusion of weights and measures. These reports show that the actual result is to increase and not eliminate confusion.

The third theory is that the metric system is in universal use, except in the United States, the British Empire and Russia. These reports show that in no country investigated is the system universal.

The fourth theory is that we must adopt the metric system if we are to succeed in selling goods to Spanish America. These reports show that if we are to change our weights and

measures in order to conform to the practice of Spanish America, we should adopt the Spanish and not the metric system.

The fifth theory is that the "adoption" of the metric system leads to an important saving of time in primary education. Clearly, with a mixture of systems in use, children have more and not less to learn.

The sixth theory is that the adoption of the metric system leads to a saving of time in calculations. Clearly, with this mixture of systems in use, involving the constant necessity for conversions between them, the labor of calculations is increased and not reduced. For example, consider the purchase at wholesale by the meter and the sale at retail by the vara.

The seventh theory is that the persistence of old units in metric countries is a persistence of names but not of things—that the practice is nothing more than the use of old names for new units. One of the most recent formal statements of this theory is by Dr. William C. Wells, Chief Statistician of the Pan-American Union, who says (*Bulletin* of the Pan-American Union, January 1917):

"It has been found somewhat difficult in countries adopting the metric scale to do away with the names of the most-used measures such as yards, quarts, pounds, miles, etc., or rather of the equivalents of those English words in the language of the country adopting the metric system. . . . It has been found very easy to substitute the thing, although sometimes difficult to substitute the word. . . . Scarcely a vestige of the old system is left in any country that adopted the metric system. Now and then in Latin-American countries one will hear the old words, but almost always with a meaning adapted to the new scale."

These replies are sprinkled with such expressions as these: "Same as in the United States." "English sizes." "For distance, the English mile." "English and metric system." "French and American indiscriminately." "Thickness of lumber is always in English inches." "Metric system infrequently." "The two standards are used indiscriminately." "The meter is used very little." "The artisans of the country use in their calculations the Spanish vara as their standard." "Our standard of weight is the quintal of 100 Spanish pounds." "The people continue to use the old Spanish measures." "At retail, vara; at wholesale, yard, meter." "While the metric system is legal it is not enforced." "In domestic business, only the Spanish system is used." "A few French articles are in metric sizes." "The cuadra is still commonly used, but is prohibited in the documents." "The English measures prevail." "Generally the English foot, exceptionally the meter." "The old Brazilian system is still commonly used." "Cloths are sold indiscriminately by meters, varas and yards." "Occasionally the metric ton." "The metric measurements are sometimes used."

Such expressions as the above, of which there are many more, cannot be thus explained.

Many of these reports *give values of the Spanish in terms of metric and English units* which show that the old names are not used for the new units, as for example:

From Costa Rica: Vara, 0.836 meter; libra, 460 grams; cuartillo, 4.165 liters; botella, 0.67 liter; manzana, 6988 square meters.

From Argentina: Vara, 0.866 meter; pie, 0.289 meter; libra, 0.4594 kilogram; tonelada, 918.8 kilograms.

From Nicaragua: Vara, 33 inches; libra, 16 onzas; fanega, 288 libras; manzana, 10,000 square varas.

Not one of all of these hundreds of sheets contains a single item to substantiate the theory advanced by Dr. Wells. No proof of it has ever been offered; it is clearly untenable and must be dismissed.

The eighth theory is that we will use metric equivalents for English sizes, or, as the metric party put it, "Whatever is manufactured must be actually the same size or weight as before. It is merely a matter of a new term of expression." Nothing to justify this theory can be found in these papers, no single example of this practice being found therein. Articles manufactured to the inch (wearing apparel, pipe, lumber, etc.) are uniformly sold by the units to which they were made.

The Result of a Great Series of Experiments

We have in this Report a composite picture of the result of many attempts to adopt the metric system, that result being uniformly the addition of that system to those previously prevailing, and it is this that we must contemplate as the result of the attempt to adopt it here. We must compare what we have with what we will get, not with what one may hope we will get. Moreover, it must be noted that had all these countries succeeded in this great experiment, it would have no significance for our guidance, because of the greater importance of our manufacturing industries. France adopted the system before the beginning of the manufacturing era, and Germany adopted it before the development of manufacturing in that country. Every one knows that the rise of Germany as a manufacturing nation began after the war of 1870. South American countries are not manufacturing countries. More manufacturing is done in the city of Philadelphia than in all South America.

We see, then, that in western Europe the system was adopted before the development of manufacturing and that manufacturing has developed with and in it, while in South America practically no manufacturing is carried on.

Great Britain and we are the first to be asked to change our manufacturing units, for which there is not a shadow of a precedent.

Seldom has an effort of such magnitude been made. We have here a record of twenty experiments on a national or, collectively, a continental, scale, and their net result is to demonstrate the wisdom of the conclusion arrived at by John Quincy Adams after four years of investigation and nearly a century ago:

"The substitution of an entire new system of weights and measures instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is, indeed, no difficulty in enacting and promulgating the law, but the difficulties of carrying it into execution are always great and have often proved insuperable.

"The legislator . . . finishes by increasing the diversities which it was his intention to abolish, and by loading his statute books only with the impotence of authority and the uniformity of confusion."

It is to protect our country from this "uniformity of confusion" that we are fighting.

The Results Are Not Surprising

Some who read this Report will, no doubt, be surprised at the condition disclosed in Spanish and Portuguese America, but there is no reason why any one should be surprised as no one has seen the first scintilla of proof to the contrary. Assertions and assumptions have been repeated so many times that, no doubt, in some cases, they have been accepted as true, but no proof has been presented and there is no proof. On the contrary, those who know weights and measures, who know the gigantic character of the task which confronts any nation

which sets out to change them, know that the inherent probabilities are all in favor of the condition set forth.

Do not confound legislation for the adoption of the metric system with its real adoption. All experience shows that while such legislation is fatally easy, the adoption of the system is impossible, the effect of the laws being to bring about nothing but the confusion and disorder that prevail throughout Latin America. Every success in the attempt to persuade some interest to introduce the system is but a step toward the confusion that prevails throughout Latin America. We have there twenty countries in which the experiment has been made with the uniform result of grotesque failure. Every expectation has been falsified and every prediction inverted. Shall we take warning, or shall we plunge headlong into this metric morass?

APPENDIX

FORM OF LETTER WHICH ACCOMPANIED THE QUESTIONNAIRES

MY DEAR SIR:

The American Institute of Weights and Measures, which is composed of many of the leading engineers and manufacturers of this country, is engaged in an extended investigation of the subject of weights and measures, and it desires to obtain at first hand definite information regarding the units of weight and measure (Spanish, metric, and English) as applied to the trade, commerce and industry of South and Central America. With this in view, the accompanying list of questions has been drawn to which we ask you to kindly reply for your locality.

The thorough character of the investigation which this Institute is undertaking will, we hope, impress you with the importance of this questionnaire, since, when all the replies are assembled, they will constitute a mass of information which is not now in existence.

It is particularly desired that answers shall be forthcoming from the smaller towns of the interior as well as from the principal cities of Latin America AND FROM INDUSTRIES AS WELL AS COMMERCE in order that the usage of weights and measures among the people may be learned. To this end we ask you to kindly make inquiry among contractors, builders, manufacturers, and, if necessary, among artisans.

Please distinguish carefully, when necessary, between the metric and English tons, between the half-kilogram and the Spanish and English pounds, the Spanish and metric quintals, and the Spanish pulgada and the English inch. When two or more units are used for the same purpose, please name them in the order of their frequency. When one unit is chiefly used, please place after it the word "Chiefly" and similarly, when one of the units is used but seldom, kindly place after it the word "Infrequent."

Your reply, esteemed sir, will place us under lasting obligations which we trust we will at some future time have the pleasure and satisfaction of discharging. In the meantime, we beg to subscribe ourselves with every consideration of respect and esteem.

Most cordially yours,

AMERICAN INSTITUTE OF WEIGHTS AND MEASURES,

..... *Commissioner.*

Questionnaire No. 1

What are the units of weight and measure commonly used with relation to the buying and selling at retail of the following products?

Groceries	Flour
Fruits	Tea and coffee
Milk, butter and cheese	Dry goods
Other farm products	Fuel
Hardware	Tobacco
Fish	Miscellaneous
Meat	

Questionnaire No. 2

What are the units of measure commonly used with relation to buying and selling articles of clothing, as follows?

Ready-made clothing	Shoes
Hats	Gloves
Collars	Corsets
Underwear and hosiery	Miscellaneous

Questionnaire No. 3

What are the units of measure commonly used with relation to the sale of lands and filing of papers and deeds, as follows?

In the farming districts
In the smaller towns
In the cities

Questionnaire No. 4

What are the units of weight and measure commonly used in the following industries?

Lumber and timber (length and thickness of boards and sizes of timbers)
By carpenters and other woodworkers
By tailors and seamstresses
By blacksmiths
In machine shops
In contracts for excavation of ground
In mines and for mineral products.
In smelting and for smelter products
Sizes of pipes for gas, water, sewers, etc.
In ship and boat building
Marine measurements (distances, maps, charts, tonnage, drafts, freight rates, etc.)
Miscellaneous

Questionnaire No. 5

What are the units of weight and measure commonly used with relation to the buying and selling of farm products at wholesale as follows?

Hay	Milk, butter and cheese
Grain	Garden products
Meat	Rubber
Root crops	Miscellaneous
Coffee	

Questionnaire No. 6

What are the units of weight and measure commonly used with relation to transportation tariffs?

Railway tariff for passengers and freight (load and distance)
Loads and rates for city transportation
Loads and rates for transportation by muleback across the mountains
Railway track gages and length of lines
Railway equipment (units used in the construction and repairing of locomotives, cars, etc.)

The Hill Publishing Company's questionnaire was considerably abbreviated from the above.

REPLIES TO THE QUESTIONNAIRES

In the complete report are summarized in great detail the replies to the questionnaires as received from the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Mexico, Nicaragua, Panama, Peru, Porto Rico, San Salvador, Spanish Honduras, Uruguay, Venezuela. As typical of the replies, the summary of the replies from the largest country, Brazil, is here given:

BRAZIL

(Summary of thirty-seven returned questionnaires)

Groceries: Liter, kilogram, gallao, arroba, gram. *Fruits:* Kilogram, arroba, alqueire; conserves in ½-kilo cans. *Milk:* Liter, garrafa of ⅔ liter. *Butter and Cheese:* Kilogram, libra; butter in packages of ½, 1 and 7 pounds and ¼, ½, 1, and 3 kilograms. *Other Farm Products:* Cargueire, quarta, kilogram, metric pound, liter, arroba. *Hardware:* Inch, kilogram, meter, centimeter, millimeter, metric ton, liter (*sic*). "Use all measures." *Fish:* Kilogram. *Meat:* Kilogram, liter (*sic*); arroba. *Flour:* Liter, kilogram, alqueire. *Tea and Coffee:* Tea in cans of ¼, ½, 1 and 5 English pounds and by kilogram; coffee, kilogram.

Dry Goods: Meter, jarda, covado.

Fuel: Wood, cubic meter, carroca, cargueire; coal, metric ton, kilogram; oil, kilogram and liter.

Tobacco: Kilogram, meter, arroba; fine tobacco, onca.

Ready-Made Clothing: Centimeter, meter. *Hats:* Brazilian, English, Italian and Portuguese numbers, centimeter, inch, meter (*sic*). *Collars:* Centimeter, meter (*sic*). *Underwear and Hosiery:* Underwear, centimeter; hosiery, inch, centimeter, meter. *Shoes:* Centimeter, numbered sizes by no apparent system, English, Portuguese, meter (*sic*). *Gloves:* Letter sizes, numbered sizes by no apparent system, centimeter, inch. *Corsets:* Centimeter, meter (*sic*).

For the Measurement of Land: In the farm districts—meter square meter, alqueire, hectare, leagua, braca, are, palmo, pollegada (*sic*), paulista, front foot, tarefa. "For agricultural lands or open lands in general the division is almost universally into alqueires." "The old Brazilian leagua is generally used." "The standard throughout the State is the alqueire." In the smaller towns—braca, alqueire, square meter, tarefa, vara, hectare, palmo, front meter, are, pollegada (*sic*). In cities—meter, square meter, braca, are, palmo, pollegada (*sic*), hectare.

Lumber and Timber: Palmo, foot, inch, pie, pollegada, meter and palmo for length, square foot, cubic meter, centimeter. "Thickness of lumber always in English inches. Width in English inch by the lumber company, and Portuguese inch by others. The lengths in feet by the lumber company and Portuguese inches by others."

By Carpenters and Other Woodworkers: Meter, inch, foot, palmo, pollegada, centimeter. *By Stone and Brick Masons:* Meter, cubic meter, square meter, pollegada, centimeter, palmo. *By Tailors and Seamstresses:* Meter, centimeter.

In Machine Shops: Meter, foot, inch, palmo, kilogram, metric ton, gram, liter (*sic*). "The metric system was established by law under the Empire as the only official system. The English system, especially for metal work, is very popular."

In Contracts for Excavation of Ground: Cubic meter, palmo, braca. *In Mines and for Mining Products:* Meter, cubic meter, metric ton, kilogram, gram, oitavo, carat. *In Smelting and for Smelter Products:* Cubic meter, metric ton, inch (*sic*), centimeter (*sic*), kilogram, gram. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, centimeter, meter for length. "English system chiefly, metric system infrequently." For the measurement of earthen pipes, the internal diameter is usually given in inches. Metal tubing for gas and water is measured by weight, per kilogram. Diameters are usually measured in inches and lengths in meters." "The English measures prevail."

In Ship and Boat Building: Meter, yard, foot, inch. "Generally the English foot; exceptionally the meter." *Marine Measurements:* Marine mile, foot for harbor charts, meter; freight by metric ton, cubic meter, kilogram; depths in meters or feet; knot, league. "English mile for distance; English foot for drafts." "English system." "The nautical mile is most commonly employed; Lloyd's registry is used in calculating tonnage." "Distances, English mile; tonnage, English ton; draft, English foot."

Hay at Wholesale: Arroba, kilogram. *Grain at Wholesale:* Liter, kilogram, prato, cargueiro quarta, alqueire, arroba. *Meat at Wholesale:* Kilogram, arroba. *Root Crops at Wholesale:* Kilogram, arroba, amarrado, metric ton. *Coffee at Wholesale:* Kilogram, arroba. *Milk at Wholesale:* Liter. *Butter and Cheese at Wholesale:* Kilogram, libra, jaca, arroba. *Garden Products at Wholesale:* Liter, kilogram. *Rubber at Wholesale:* Kilogram, arroba.

Railway Tariff for Passengers and Freight (Load and Distance): Kilometer, metric ton, cubic meter. *Loads and Rates for City Transportation:* Kilometer, tonelada, cubic meter, arroba, metric ton, kilogram. *Railway Track Gages and Length of Lines:* Meter, kilometer, centimeter. *Railway Equipment (units used in the construction and repairing of locomotives, coaches, etc.):* Inch, foot, kilogram, meter. "Weight, kilo; measure, English inch."

"The official system of weights and measures, etc., is the metric system. However, the old Brazilian system is still commonly used." According to the Report to the International High Commission on the Metric System in Export Trade, the metric system is "obligatory" in Brazil.

Brazil "adopted" the metric system in 1862.

VALVES AND FITTINGS FOR HIGH HYDRAULIC PRESSURES

Their Design and Maintenance in Operation for Pressures of from 1000 to 8000 Lb. per Sq. In.

BY WM. W. GAYLORD,[1] TORRINGTON, CONN.

WITH the greater use of hydraulic machines of various sorts as the result of the large manufacture of munitions, a greater interest is to be expected in the design of valves and fittings for such machines. This paper gives the results of my experience, and I have written it largely in the hope that others may be led to publish the results of theirs.

A few years ago when the problem was presented to me of designing a new hydraulic system for a working pressure of 5000 lb. per sq. in., with the probability that this would be increased to 7500 lb. per sq. in., I found there had been very little published on the design of valves and fittings for this pressure, and that the designing formulæ given in standard handbooks were either incorrect or unsatisfactory. The formula most generally given was that of Lamé, based on the maximum-stress theory, which, while correct for cast iron, is not satisfactory for steel. Lanza, in his Applied Mechanics, gives a modification of the Grashof formula based on the maximum-strain theory which I had used before with fair results for steel fittings on lower pressures. I had, however, noticed some unaccountable failures when applied to pipe and fittings using a working pressure of 4000 to 4500 lb. per sq. in.

While studying these failures my attention was called to the maximum-shear theory proposed by Guest, and this seemed to explain most of them. About this time the results of the experiments of Cook and Robertson were published in *Engineering*, December 15, 1911, and after considerable study I became convinced that these offered the best basis for design.

The form in which they give the formula for fiber stress, based on the maximum-shear theory, is

$$\frac{P}{f} = \frac{K^2 - 1}{2K^2}$$

where P is the internal pressure in pounds per square inch, f the fiber stress, and K the ratio of external to internal diameter. This is the equivalent of the usual formula

$$f = P \frac{2}{1 - \frac{d_0^2}{d_1^2}}$$

where d_0 is the internal diameter, and d_1 the external diameter.

The results of their experiments show that if a factor of 1.2 were introduced the equation would more nearly represent the actual results, so the formula suggested by them becomes

$$\frac{P}{f} = 1.2 \frac{K^2 - 1}{2K^2}$$

By substituting $\frac{r + t}{r}$ for K in this formula, the thickness t of cylinder wall of a cylinder of inside radius r becomes

$$t = -r \pm \sqrt{\frac{Pr^2}{0.6f - P} + r^2}$$

From this formula it is apparent that a material having a working fiber stress of 12,500 lb. per sq. in. or less would not be safe however thick the pipe wall. This, of course, eliminates

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For presentation at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

bronze, cast iron and semi-steel as materials for making these fittings. After careful consideration of the materials available it was found that cold-drawn seamless steel pipe annealed to give 45,000 lb. per sq. in. elastic limit, and steel castings for fittings giving 30,000 to 35,000 lb. per sq. in. elastic limit, could be obtained, and it was decided to use these.

As the system had no accumulator and therefore was not subjected to severe shocks, a working fiber stress of 0.6 of the elastic limit was used.

The largest pipe in the system was to take the discharge of five pumps, each of 60 gal. per min. capacity, making a maximum flow of 300 gal. per min., but most of the time only three pumps or 180 gal. would be used. In view of this a maximum velocity of 20 ft. per sec. or a usual velocity of 12 ft. per sec. was allowed which required a pipe of $2\frac{3}{4}$ in. inside diameter. From the above formula the thickness required for a pipe of $2\frac{3}{4}$ in. inside diameter is

$$t = -1.375 \pm \sqrt{\frac{7500 \times \overline{1.375}^2 \times 2}{0.6 \times 27000 - 7500} + \overline{1.375}^2}$$

$$= -1.375 \pm \sqrt{\frac{28360}{17400} + 1.891} = -1.375 \pm 1.876$$

$$= 0.51 \text{ in.}$$

and for a fitting

$$t = -1.375 \pm \sqrt{\frac{7500 \times \overline{1.375}^2}{.6 \times 19500 - 7500} + \overline{1.375}^2}$$

$$= -1.375 \pm \sqrt{\frac{28360}{8400} + 1.891} = 0.925 \text{ in.}$$

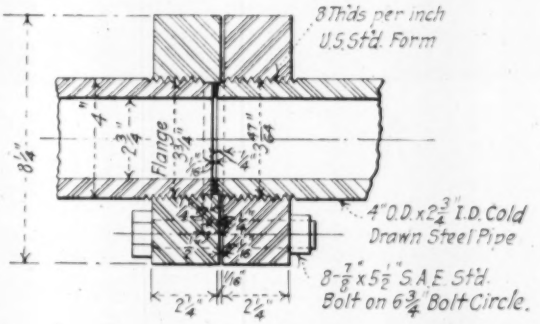


FIG. 1 TYPICAL FLANGED JOINT FOR 7500 LB. PER SQ. IN.

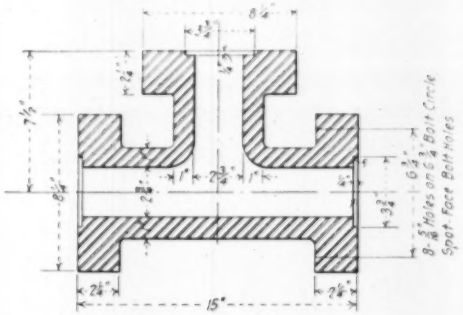


FIG. 2 TYPICAL FLANGED FITTING FOR 7500 LB. PER SQ. IN.

A pipe having 4 in. outside and $2\frac{3}{4}$ in. inside diameters was chosen, as this was a commercial size and allowed the necessary thickness of metal for threading to use in a joint of the type shown in Fig. 1. The fittings were made with a 1 in. wall thickness, the tee shown in Fig. 2 being an example of the type used.

The bolting of the flange was figured by assuming that the full pressure was applied to the area of a circle of the outside diameter of the gasket. In the joint in Fig. 1 this would make a total load on the bolts of $(1.875)^2 \times 3.142 \times 7500 = 83{,}150$ lb., which would require eight $1\frac{3}{8}$-in. bolts if U. S. standard bolts were used, allowing a working fiber stress of 10,000 lb. per sq. in. This would have taken a flange about 11 in. in diameter and would have made the piping very hard to install in the limited space available, so it was decided to use bolts made to the S. A. E. or, as it was then known, the A. L. A. M. standard. Using a working stress of 22,500 lb. per sq. in., this allowed the use of eight $\frac{7}{8}$-in. bolts in an

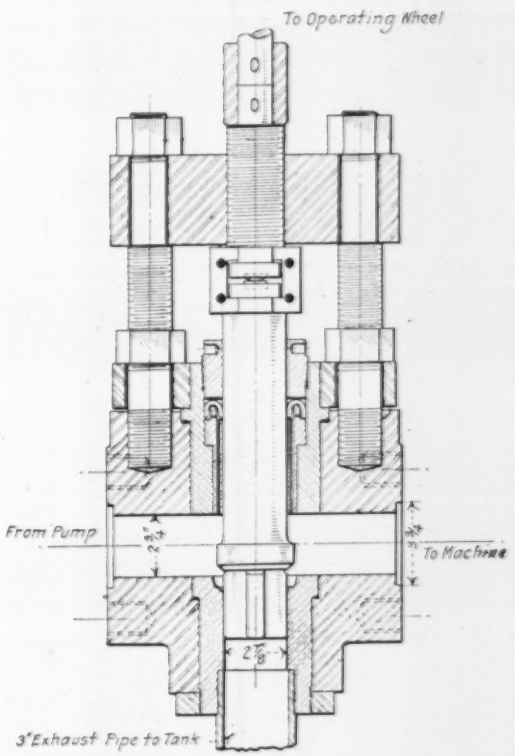


FIG. 3 OPERATING VALVE FOR 7500 LB. PER SQ. IN.

$8\frac{1}{4}$-in. flange. This is open to the objection that a careless mechanic may replace these special bolts with standard bolts and thus cause the failure of the joint, but there has been no trouble from this cause.

When the piping was installed, some of the gaskets were of soft copper and the rest of red fiber, but experience has shown red fiber to be more satisfactory as the copper soon hardens and a slight water hammer will often start the joints leaking, while the red fiber does not give this trouble.

The system was to supply three machines from a group of five pumps, and the piping was to be so arranged that the large machine, which was to use pressures up to 7500 lb. per sq. in., could be operated with any or all of the pumps while the other two machines were to be operated with one or two pumps each, but the connections were to be so made that any pump could be connected to any machine. This was done by using a manifold tee on the discharge of each pump with a valve connecting to each pipe line.

The valves originally put in were of two types: one a wedge gate valve with cast-steel body and hard bronze wedge, the other a stop valve of the balanced type having cast-steel body and bronze plunger. The gate valves proved impracticable as the bodies could not be made sufficiently rigid to prevent distortion of the seat and the starting of a leak which would

grow very rapidly because of the cutting action of the water. The other valves were more satisfactory and could be kept fairly tight by frequently dressing the seat and plug; but it was found more satisfactory to use blank flanges and pipe spools in place of the valves to make necessary changes in connections.

The machines were in effect single-acting presses in which the ram was returned by an auxiliary low-pressure system. The main operating valve therefore became a bypass valve which was closed to drive the ram forward and opened to allow the ram to stop and be returned. The valve in Fig. 3 was chosen for this place and was first made without the loose connection shown in the stem, but it was found very hard to open it after it had been shut tight, so the connection was added and this difficulty overcome. Experience had shown that the rather difficult to build, it has proved very satisfactory.

On a smaller press having three double-acting cylinders designed to operate in regular sequence, a multiple valve of the semi-balanced spring-closed type was used, having the individual valves opened by bell-crank levers moved by face cams mounted on a common shaft. The cams were so arranged that rotation in one direction would cause the cylinders to operate in the proper order. The valve was so designed that when open the area through the seat was greater than around the stem.

In designing valves and fittings for service on accumulator systems I have found that it is usually the severity of the water hammer rather than the actual pressure that determines the strength required and that in laying out such a system all possible care should be used to avoid trouble from this source.

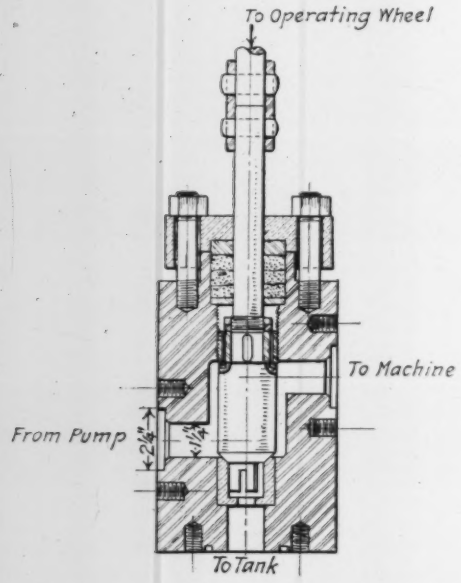


FIG. 4 OPERATING VALVE FOR 5000 LB. PER SQ. IN.

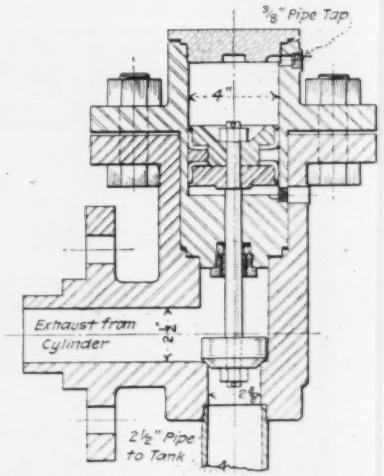


FIG. 5 CAST-STEEL EXHAUST VALVE USED TO REPLACE VALVE IN FIG. 6

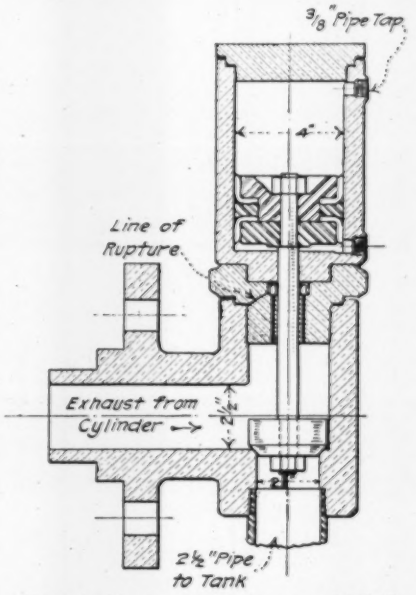


FIG. 6 EXHAUST VALVE FOR 5000 LB. PER SQ. IN.

form of seat used with the beveled recess for the plug would last much longer than if the valve had a flat seat.

This system has been in use five years, often with a working pressure of 8000 lb. per sq. in. for short periods, with no failures, and with the exception of the valves mentioned has given good satisfaction.

On two similar systems more recently installed for operating pressures of from 4000 to 5000 lb. per sq. in. the same type of pipe and fittings has also been used with success. The operating valves furnished for these systems were made as shown in Fig. 4 and proved unsatisfactory, as the water pressure on top of the plug held the valve closed so that it was almost impossible to open it. These were replaced by valves similar to Fig. 3, which are working satisfactorily.

These machines had an exhaust valve as shown in Fig. 6 which returned the water direct from the main cylinder to the tank on the return stroke of the ram. These gave much trouble by the intermediate piece between the valve body and operating cylinder breaking through as indicated. This in two cases blew the operating cylinder entirely off the valve body. Two of the valve bodies also failed by splitting. In view of this and the fact that a leakage through the U-leather packing might also blow the operating cylinder off, it was decided to redesign this valve, using a cast-steel body and cylinder arranged to eliminate these faults. Fig. 5 shows this valve, and although it is

However, as the severity of water hammer in a new system can never be exactly determined before it is in operation, I have used the designing formula given in the first part of this paper, with a working fiber stress of one-third to one-half the elastic limit of the materials employed, depending on the probable severity of shock from this cause. This I have attempted to check by figuring the rise of pressure to be expected due to the inertia of the moving parts of the accumulator if all operating valves should be closed at the same time. This is done by assuming the ram of the accumulator to be coming down with a maximum velocity and figuring the force necessary to cause a negative acceleration sufficient to stop it in an assumed minimum time of closing the valves. This at best can only be a rough check but has proved sufficient in several cases. The piping should be so supported and anchored that water hammer will not cause any considerable whip, as this is the usual cause of broken fittings and leaking joints.

The valve most used to control single-cylinder machines like draw benches on an accumulator system is a combined throttle and reversing valve, while the valves for multi-cylinder machines are too numerous and complex to describe in this paper; but the principles used in their design are the same as for the valve already described, except that greater care must be exercised to prevent too rapid opening and closing and consequent destructive water hammer.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, Including Abstracts of Articles in Current Technical Periodicals

Italy to Have Aerial Laws

THE Italian Government has just completed the draft of a series of laws covering aerial navigation. First of all, the law fixes the technical names to be used in designating the more important aspects of aerial navigation. All aircraft, whether airplanes or dirigibles, will be known under the general name of aeromobiles. Aerial ports will be the name applied to the regular places for landing and departing, while refuge ports will be the name applied to those landing places where the aerial craft can put in in case of accident.

The law provides that regular aerial ports are to be equipped with very much the same facilities as are to be found in any great seaport for the landing, unloading, repairing and taking on of cargoes.

Special articles provide for what an aeromobile must do if obliged to land in other than a regular or refuge aerial port.

Special provisions govern the zones of altitudes in which the aeromobiles must navigate to prevent collisions and other accidents.

For reasons of national defence, there is an article prohibiting aeromobiles from flying over forts and other military and naval defences. The proposed laws would prohibit transportation by aeromobiles of inflammable matter, explosives and other kinds of merchandise that might endanger the aircraft and other property in case of accident.

Other articles provide that all aeromobiles must be registered in the national registry of aircraft; that each aeromobile must have a government certificate of its navigability; that there must be officers of recognized competency aboard, and that each aircraft must carry certain official documents.

The proposed code, in all probability, will be made law at the coming session of Parliament. (*The Evening Sun*, New York, Oct. 4, 1918, p. 20)

New German Textile Substitutes

In THE JOURNAL for July (p. 581) reference was made to a German textile substitute, a wood-pulp fiber called "cellulon." Further information regarding this and other substitutes is given below.

Paper yarn, which has been used in the manufacture of sacks, carpets, beltings, and like articles not washable and of a coarse fabric, has not yet been found suitable for clothing. From cellulon, however, a yarn is obtained somewhat better than paper yarn, but still not fitted for anything but coarse fabrics.

Another product, "Stapelfaser," seems to promise better results. In the manufacture of paper yarn the cellulose fiber is cut off when the paper is cut into strips for the spinning machines. Efforts are now being made to secure longer fibers from cellulose. In the manufacture of Stapelfaser the cellulose treated with certain chemicals is dissolved to a jelly-like mass, which is pressed through very fine strainers, thus producing fine fibers. These fibers are then twined together into coarser threads. The thread is rolled up and cut into pieces from 4 to 5 cm. (= 1.57 in. to 1.97 in.), which are put through a drying process, during which the fibers part from each other, leaving sufficiently long and fine threads. This method of manufacture is somewhat similar to the one used in the manufacture of artificial silk.

Stapelfaser is claimed to replace cotton and wool, except that it is not as washable. It may be washed, but when wet must not be pulled. As soon as dry it is just as good as before. However, if, when weaving, a small portion of wool or cotton is inserted, a full washable fabric is obtained.

The above facts are from the *Frankfurter Zeitung*, which journal, however, claims that the textile question is not yet fully solved. It states that the production of clothes from Stapelfaser has already been started at several factories in Germany, but that the products have been taken by the military authorities for the needs of the army. Even if the method is technically finished, production is dependent upon the supply of raw materials and mainly chemicals. Both the raw materials and the chemicals necessary are available in Germany, but not in sufficient quantities.

The Textile-Industrie A. B., in Barmen, has succeeded in obtaining a product from cellulose yarn which, without any dressing, can replace leather and from which shoes are said to have been successfully made. (*Commerce Reports*, no. 233, Sept. 23, 1918, p. 1114)

War Department Committee on Education and Special Training

The Committee on Education and Special Training of the War Department has issued a special bulletin on programs in engineering which is intended to indicate how existing courses at schools may be modified by eliminations and condensations so as to meet the needs of the present emergency.

A significant feature of the programs is the inclusion of the subject of war issues in two terms. The approved course in mechanical engineering is as follows:

MECHANICAL ENGINEERING

	Hours per week
1ST TERM	
Mathematics	12
Drawing and Descriptive Geometry	9
Chemistry	12
War Issues and English Composition	9
2D TERM	
Mechanism	9
Mathematics	12
Chemistry	12
War Issues and English Composition	9
3D TERM	
Mechanism and M. E. Drawing	10
Mathematics	12
Physics	14
Shopwork	4
Surveying, Map Reading and Topographical Drawing	7
4TH TERM	
Applied Mechanics	12
Mathematics	12
M. E. Drawing	5
Physics	14
Shopwork	4
5TH TERM	
Heat Engineering and Eng. Lab.	15
Electrical Engineering	10
Applied Mechanics	12
Machine Drawing	6
Shopwork	4
6TH TERM	
Heat Engineering and Eng. Lab.	15
Hydraulics	11
Applied Mechanics	10
Electrical Eng. Lab.	7
Shopwork	4
7TH TERM	
Materials of Engineering and Testing Materials Lab.	12
Mechanism of Machines	5
Machine Design	10
Applied Mechanics	10
Refrigeration	2
Engineering Lab.	4
Shopwork	4
8TH TERM	
Power-Plant Design	5
Industrial Plants, including Heating and Ventilation	16
Mechanics of Engineering	7
Engineering Lab.	10
Gas Motors or Heat Treatment	5
Shopwork	4

Shipyards and Shipways

When the present Shipping Board began its work, in August 1917, there were only 61 shipyards in the United States. There were 37 steel shipyards with 162 ways. About three-quarters of their capacity had been preëmpted by the naval-construction program, while private orders overflowed the remaining ways. In the 24 wood shipyards there were only 73 ways.

The largest shipyards in the world in September 1918 are those of the United States. The Clyde River, in Scotland, historically famous as the greatest of all shipbuilding localities, is already surpassed by two shipbuilding districts on the Atlantic coast and by two on the Pacific coast—by Delaware River and Newark Bay in the East and by Oakland Harbor and Puget Sound in the West. One yard, Hog Island, on the Delaware, is equipped to produce more tonnage annually than the output of all the shipyards of the United Kingdom in any pre-war year. It has 50 ways.

There are now 203 shipyards in the United States. The list comprises 77 steel, 117 wood, 2 composite and 7 concrete shipyards. Of these, 155 are completed, 35 more than half completed, and only 13 less than half completed. The great plant at Hog Island is 95 per cent completed—built in one year on a site formerly a swampy marsh.

Every month of the past year has added to the number of American shipways, until today the impressive total is 1020—more than double the total of shipways in all the rest of the world. Of the 927 shipways that are for the Emergency Fleet Corporation of the Shipping Board, 810 are listed today as completed, and only 117 are to be added. There are 410 completed ways for the construction of steel ships, 400 completed ways for the construction of wood, composite and concrete ships. (*Shipping Facts*, issued by U. S. Shipping Board)

Fourth National Exposition of Chemical Industries

The Fourth National Exposition of Chemical Industries, Grand Central Palace, New York, September 23 to 28, 1918, was signalized by the gathering of a notable body of men engaged in the various industrial applications of chemistry. Various addresses were made comprising a series of symposiums devoted to the consideration of the development of the chemical industries in the United States, notably since July 1914.

Tons of machinery and material were exhibited, transported in spite of present war difficulties, which tangibly attested America's approach to chemical leadership. The achievements in the production of dyestuffs and explosives and acids; the independence of the potash industry, of vital importance to the United States; the wonderfully encouraging and typically American progress of the ceramic industries; the new achievements in metals and alloys in which we have long held high rank; and the growing importance of organic chemistry in the arts and industries, were abundantly evidenced by the varieties of new devices and methods exhibited.

The Chemical Warfare Service of the United States Army displayed the developments in chemical warfare. Originals and photographs of various types of masks were shown. The new American type was also displayed, and its future use in mines was clearly indicated. Offensive gas warfare was represented by specimens of shells and grenades of many sorts. They are designed for the various different types—sneeze, mustard, lethal, phosphorus (for incendiary work and to produce white smoke) and others. An oval form of shell was shown that may fall into any position without becoming a "dud"—a shell that fails to explode.

Copies of rules and general orders relating to chemists and engineers in essential industries and providing for the allocation of enlisted men were distributed by the chemical-warfare exhibit.

New York Section of American Society of Refrigerating Engineers

At the meeting of the New York Section of the American Society of Refrigerating Engineers, held on September 18 at Machinery Club, New York, Charles N. Neeson gave an informal talk on his experience with electrically operated high-speed refrigerating machines. He stated that these machines are started much quicker and easier when the bypass as well as the suction and discharge valves are closed, especially when the back pressure is high. It is necessary to shut the discharge valves when starting on account of leakage through other valves. With the introduction of the high-speed ammonia compressor, the selection of proper valves giving large clearance to the compressors is essential for the successful operation of the machines. In the plant of Mr. Neeson's company, with 18 cans per ton of ice, 35 kw-hr. per ton was achieved, and for the summer conditions, 22 kw-hr. per ton. With a cooling-tower plant 32 kw-hr. per ton was had, and for summer conditions, 12 cans per ton, 60 kw-hr. per ton of ice. The compressors have center ports and the indicator diagrams showed a 5-lb. drop in the suction pressure, with 20 lb. excess above the head pressure at the end of compression. There was about 25 per cent reëxpansion with the high head pressure.

F. L. Fairbanks said that on the whole the tendency was to give high-speed compressors too little total valve area. There is a tendency on the part of the operator to make plate and feather valves give from two to four years' service, whereas a feather or a plate valve should be changed every six months to avoid serious recesses in the valve seats. In reference to the effect of inertia of the reciprocating parts, Mr. Fairbanks said that with his 1000-ton compressor, which has a 24-in. shaft, 28 ft. long, running at 45 r.p.m., the machine could be run with the caps and quarter-boxes out of the bearing, but at 50 r.p.m. the 150-ton shaft was lifted off the bottom bearings owing to the inertia of the pistons and other reciprocating parts.

The meeting manifested an anxious interest in the question of flywheel effect for high-speed compressors, and particularly for the compound type driven with synchronous motors. Experience seems to show that where there are a number of these machines in one plant, any one running singly gives no trouble in the way of regulation, but when two or more of appreciably different capacities are in parallel, considerable trouble is experienced in regulation. (From account of the meeting given in *Power*, October 1, 1918)

Western Society of Engineers

A meeting of the Western Society of Engineers was held in Chicago on September 23, under the auspices of the hydraulic, sanitary and municipal section. W. G. Edens, President of the Illinois Highway Improvement Association, in a paper on Illinois roads, explained the need for improved highways and, referring to the proposed $60,000,000 bond issue to be voted on November 5, he laid stress on the part engineers can play in promoting this program for after-the-war work, as under the terms of the proposed issue the bonds are not to be sold until after the war.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

COPPER, EFFECT OF COLD WORK ON
STEEL, CHEMICAL FORMULA FOR TENACITY
DIESEL ENGINES FOR MOTOR VEHICLES
DIESEL ENGINES, FUEL INJECTION AT VARIABLE PRESSURE
GAS BLOWING ENGINE, 1500-HP.
FLYWHEEL EXPLOSION AT CHICAGO
SCREW-THREAD ANGLES, RELATION TO OTHER FUNCTIONS
SCREW-THREAD STANDARDIZATION
PISTON RINGS, CENTRIFUGALLY CAST
YARROW ANTI-SUBMARINE SMOKE SYSTEM
EAGLES, MANUFACTURE AT FORD SHIPYARD
HEAVY-OIL-BURNING ARRANGEMENTS FOR MOTOR CARS
BY-PRODUCT INSTALLATION FOR POWER STATIONS
POWER-STATION PLANTS, COMPARISON OF TYPES
CEDAR RAPIDS STEAM PLANT
UNDERFEED STOKERS ON LOW-GRADE COAL
PENNSYLVANIA SALT MFG. COMPANY'S PLANT
INDICATING INSTRUMENT EQUIPMENT OF LARGE PLANT
EDUCTOR CONDENSERS
RENEWABLE STAY HEADS FOR LOCOMOTIVE FIREBOXES
THROTTLING OF AMMONIA
PUMPING ENGINES FOR CAIRO MAIN DRAINAGE
PUMPING ENGINES, ARRANGEMENT OF HIGH AND FIRST INTERMEDIATE CYLINDERS
MARTIN THEORY OF STEAM TURBINE
DETERMINATION IN STEAM TURBINE OF POINTS OF LOSS OF INITIAL SUPERHEAT
INDICATED HYDRAULIC EFFICIENCY OF IMPULSE TURBINES
GRAPHIC METHOD OF DETERMINING SIZE OF SAFETY VALVES
STEAM-ENGINE GOVERNING
CASE-HARDENING MATERIALS, RELATIVE MERITS
TELESCOPIC FOCUSING APPARATUS FOR PHOTOMICOGRAPHY
STRAINAGRAPH

For Articles on Subjects Relating to the War, see Engineering Materials, Machine Parts, Marine Engineering, Refrigeration, Testing

Engineering Materials

THE EFFECT OF COLD WORK ON COPPER, W. E. Alkins. An investigation to determine whether any quantitative relationship exists between the amount of cold work done upon the metal and the magnitude of the change in its properties.

In particular, an account is given of an inquiry into the change in tensile strength of copper in the form of wire as it is progressively hardened by cold drawing in the ordinary way.

Copper was chosen as the experimental material for three reasons: (1) It appeared to afford an example of a simple metallic system which is supposed to undergo no definite thermal change between its melting point and the ordinary temperature (though an allotropic modification of copper with the transition point at about 70 deg. cent. is claimed to exist by Cohen); (2) copper shows the hardening by plastic deformation very well; and finally, in this particular instance, it was most readily obtainable by the author in the required form and of superior purity, in particular, 99.92 copper with the remainder consisting of oxygen with a smaller amount of arsenic.

The author gives a brief discussion of the previous work by Thomas Bolton, A. P. Trotter and D. R. Pye. Of these Trotter concluded that there was a linear relation between the tensile strength and the diameter, and suggested that the tensile strength might be expressed by a formula of the type

$$T = a - bD$$

where T is tensile strength in tons per sq. in., D diameter in inches, and a and b are constants.

The method of carrying out the tests and taking the various measurements is described briefly and the results given in the form of tables and curves. The results of tensile tests give a smooth curve for the tensile strength against diameter of sectional area, but at the same time show conclusively that the effect of a certain amount of cold work at any stage is intimately connected with the previous history of the metal.

From this point of view the curve of Fig. 1 is of interest. This curve showing the variation of tensile strength with sectional area consists of two rectilinear portions, AV, CD, connected by a smooth curve BEC. This curved portion shows only a point of inflection at E, and not a maximum and minimum.

The portion AB corresponds to the equation:

$$T = 31.6 - 67A$$

where T = tensile strength in tons per sq. in;
A = cross-sectional area in sq. in.

The upper rectilinear branch CD corresponds to the equation:

$$T = 30.83 - 82.66A$$

The curved portion BEC agrees very closely with the expression:

$$T = 23.2 - \sqrt[3]{A - 0.107}$$

but while the form of this portion is of the first importance,

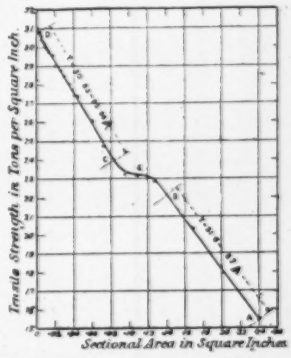


FIG. 1 CURVE SHOWING VARIATION OF TENSILE STRENGTH WITH SECTIONAL AREA

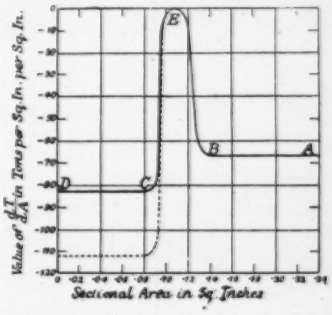


FIG. 2 CURVE OF DIFFERENTIAL OF CURVE OF FIG. 1 WITH RESPECT TO CROSS-SECTIONAL AREA

the corresponding mathematical function is only of secondary interest.

Significance of the Curve of Fig. 1. Differentiating the curve of Fig. 1 with respect to area (A), we have:

Over the portion AB, $\frac{dT}{dA} = -67$; from B to E the value of $\frac{dT}{dA}$ changes from -67 at B to 0 at E; from E to C the value of $\frac{dT}{dA}$ diminishes from 0 at E to -82.66 at C, and over

the branch CD, $\frac{dT}{dA} = -82.66$ (*cf.* Fig. 2, which is lettered to correspond with Fig. 1).

Thus, from A to B the tensile strength increases at the rate of 67 tons per sq. in. for a reduction in area of 1 sq. in., while from C to D the rate of increase is 82.66 tons per sq. in. per sq. in.; the rate diminishes from B to 0 at E, and increases again from E to C; the curve shows no discontinuity, and at no stage is there a simultaneous diminution in sectional area and in tensile strength. From the foregoing considerations it appears that in the drawing of copper the phenomena which present themselves are not of that simple nature which the amorphous theory would lead one to expect.

The variation of several other physical properties of the metal was investigated and such properties as density, elongation, scleroscope hardness, and so on, were all found to change in a way similar to tensile strength. The following tentative explanation of the above results has been suggested: When copper is subjected to cold work by drawing through dies the first change which occurs is allotropic in nature. After this change is complete, that is, presumably when the whole of the metal has undergone transformation, a second change sets in which may be regarded either as allotropic or as explicable on the lines of the amorphous theory, and of the two possibilities the latter appears to be the more probable. (Paper read before the Institute of Metals on September 10, 1918, abstracted through *Engineering*, vol. 106, no. 2770, September 13, 1918, pp. 282-285, 4 figs., *eA*)

THE INFLUENCE OF SOME ELEMENTS ON THE TENACITY OF BASIC STEEL, Andrew McWilliam. The writer proposes a new formula for calculating the maximum load from the composition of steel. The first formula given for basic steel was

$$\text{Maximum load in lb. per sq. in. of original section} = 38{,}000 + 800\text{C} + 100\text{Mn} + 1000\text{P}$$

in which the carbon, manganese and phosphorus are expressed in units of 0.01 per cent. It was found, however, that under certain conditions this formula did not give correct results. Thus, around 0.2 per cent carbon the results were correct, but at 0.5 per cent carbon they were too low. It was thought then that as the carbon would be present in the form of pearlite to which the added strength was due, the more pearlite present the greater effect the carbon would have per unit on the tenacity of the mass. Further, as the manganese influenced the nature of the carbon, its influence would increase with increasing proportions of pearlite. Another calculation was made with the result that the maximum load in pounds per square inch of original section is expressed by the following formula:

$$\text{Maximum Load} = 38{,}000 + [800 + 4\,(\text{C} - 20)]\,\text{C} + 120\text{Si} + [100 + 2\,(\text{C} - 20)]\,\text{Mn} + 1000\text{P}$$

This formula has stood the test of trial quite well and even with the higher-silicon shell steels has given good results.

To check the correctness of this formula the writer compares the results derived by this means with those obtained experimentally by Arnold and shows that the two are in close agreement. (Paper before the September 1918 Meeting of the *Iron and Steel Institute*, abstracted through advance copy, 13 pp., 3 figs., 5 tables, *eA*)

Internal-Combustion Engineering

DIESEL ENGINES FOR MOTOR VEHICLES. Notwithstanding the great amount of work devoted to this purpose no one has succeeded in developing a Diesel-engine drive for motor vehicles.

This is due to the fact that no small high-speed multiple-cylinder Diesel engines have yet been constructed, and this again is mainly due to the difficulty of building a reliable small pump that would deliver air at about 100 atmos. pressure and would be easy to operate notwithstanding its many valves and regulating devices.

Austrian Patent No. 72356 describes an attempt to inject the fuel into the combustion chamber at variable pressure, but with a constant position of the needle valve.

With such an arrangement it was found that it is quite feasible to introduce into the cylinder the exact predetermined amount of fuel and to regulate it at will. The experimental installation consists of a three-cylinder, two-stroke-cycle engine with cranks at 120 deg. To use the engine for motor-car driving it is necessary to provide two steel flasks filled with air at 70 atmos. pressure. One of the flasks serves to start the engine, while the other delivers air for fuel injection. When the engine is running it makes its own compressed air. The flasks hold 1400 liters of free air each and can easily be carried on the car. For purposes of starting the air pressure is reduced to 10 atmos. (the original article does not state whether gage or absolute pressure is referred to).

The fuel injection occurs during 25 deg. of the crank rotation. In the experimental engine exhaust slots are provided along the entire circumference of the cylinder, but the scavenging air enters only through its own valve in the cylinder head. It is the view of the inventor that slots for the admission of scavenging air should be avoided, because at great speed a thorough scavenging by means of slots cannot be secured, and, further, if slots are used both for the scavenging air and for the exhaust, unequal expansion of the cylinder walls is apt to occur.

The scavenging valve opens after the piston has uncovered half the height of the exhaust slots and therefore permitted a complete expansion of the gases of combustion to occur. The scavenging air enters the cylinder at a pressure of 0.34 atmos. and an excess of 50 per cent of scavenging air is provided. The air valve remains open at exactly 90 deg., or one-fourth of the crank revolution. The exhaust slots remain open for 110 deg. The scavenging air is produced by the engine itself, an expansion piston being added to the working piston for this purpose. The air of combustion is compressed in the cylinder at 35 atmos. and is thereby raised to 580 deg. cent.

For the sake of safety the engine is driven by kerosene and for its injection into the cylinder an air pressure of from 40 to 70 atmos. is needed. This is obtained by means of an air compressor driven by the engine. The fuel flows to the pump automatically. The pump is driven from the engine at a speed reduction of 1:10 corresponding to the air-compressor drive. The fuel pump takes up the fuel by suction and forces it into the air container, having a capacity of about 1 liter, in which there is air compressed to from 40 to 60 atmos., but the fuel pump has absolutely nothing to do with the engine governing. The overfilling of the container is prevented by a simple governing device which acts on the suction valve of the fuel pump by the pressure in the air container.

The working cylinders are made of steel and form a unit with the scavenging air cylinders located underneath. The use of steel results in a considerable saving in weight, as well as a better cooling than would be the case with cast iron.

The air compressor is so large that the supply of starting air can be replaced in any case within a quarter of an hour after starting. The compressed air which forces the fuel into

the cylinder either does not reach the combustion chamber at all, or else in very small amounts. In this way but very little injection air is used and, therefore, the air compressor can be quite small and can be run at the low speed of 120 r.p.m., which materially increases the reliability of operation. While in an ordinary Diesel engine 8 cu. m. of injection air would be consumed, the new injection method permits using the same amount of air as of fuel, or at most 0.088 cu. m. The air compressor is single-acting two-stage and compresses in the first stage to 8.4 atmos. and in the second stage to 70 atmos.

The fuel valve has a needle in constant position. The fuel goes into an annular distributing chamber and is given a rotary motion in its helical passages. From this chamber it enters the combustion space through the fine holes in the nozzle, which is shaped like an injector. By the injector action of the fuel jets a strong turbulent motion of the air is created in the combustion chamber which leads to a good mixture of the fuel with the compressed air in the cylinder. Since no injection air is allowed to enter the cylinder, the undesirable cooling of the mixture is avoided. It is claimed that extensive tests have been made with the new system of fuel injection in order to determine whether the fuel chamber is necessary for governing the engine. These tests have also shown that the atomization of the fuel is perfect and that no drops are formed from the fuel present in the nozzle. In order to determine the quality of atomization the fuel was allowed to discharge into the atmosphere and the kerosene mist was ignited for experimental purposes. It was found that when the nozzle was kept open for some time the length of the flame varied with various air pressures from 1.5 to 2.5 m.

In the original article a diagram is given showing that the amount of fuel ejected is proportional to the air pressure, though at higher pressures the increase in the ejection of the fuel is not as great as with smaller pressures. This may be explained by the fact that at higher pressures and greater velocities in the nozzle passages the coefficient of friction increases more rapidly. (*Dieselmaschinen für Fahrzeuge, Allgemeine Automobilzeitung,* nos. 29-32, abstracted through *Dinglers Polytechnisches Journal,* vol. 333, no. 4, February 23, 1918, pp. 31-32, 1 fig., *e*)

1500-HP. GAS BLOWING ENGINE. Very brief description, with two pages of illustrations, of a gas engine and blower recently built in England for the Partington Steel and Iron Company. The engine is of the 6-crank vertical tandem type, and is rated to develop 1500 b.hp. on continuous load at 200 r.p.m. working on blast-furnace gas of 90 to 100 B.t.u. per cu. ft. The load can be increased by 10 to 20 per cent for short periods without overheating. A special speeder gear device is fitted to enable the speed to be reduced to as low as 120 r.p.m. (*The Engineer,* vol. 126, no. 3271, September 6, 1918, p. 207, and 2 pp. of illustrations, *d*)

Machine Parts

DISASTROUS FLYWHEEL EXPLOSION AT CHICAGO. At 2.00 p.m. on the afternoon of September 19 a large flywheel exploded in engine room No. 1 of the Chicago Coated Board Company with considerable damage to life and property. The engine to which the flywheel was attached was a 24-in. by 42-in. 500-hp. simple Corliss making 108 r.p.m.

The flywheel had six spokes, had been cast in halves and bolted together at the hub and rim. The engine was thoroughly protected against overspeeding by a flyball governor equipped with the usual safety stop and by an additional engine stop arranged to be operated mechanically and electrically. Evidence indicates that the accident was not caused by overspeeding, and further, the load was constant and the speed normal.

The engineer's attention was first aroused by the noise of escaping steam and immediately after by the commotion caused by the flying parts of the wheel. The flywheel had been broken to bits, there being only two large pieces, one containing two spokes and the intervening rim, and the other a single spoke. Curiously enough, the engine to which the ruptured flywheel belonged was not damaged in the least.

The theory of the accident is that a small part of the rim first let go, severing the steam pipe, as the noise of escaping steam first heard would indicate. This so badly unbalanced and weakened the wheel that it could not withstand the strain imposed by the peripheral velocity of 4920 ft. per min.

In cast-iron rims of the section adopted for this wheel, namely, one having unequal thicknesses of metal, severe internal stresses may be set up by uneven cooling in the mold. While there were no signs of blowholes or other defects, the design of the wrecked wheel is very weak. It was made in two

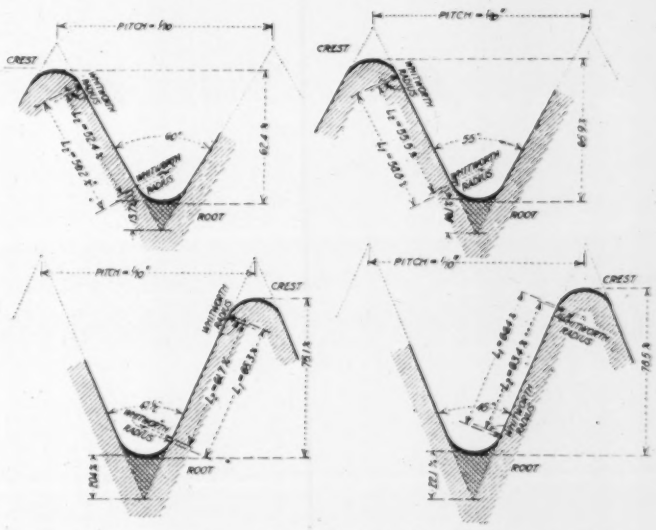


FIG. 3 COMPARISON OF SCREW THREADS OF VARIOUS ANGLES

parts with flanged and bolted rim joints located between the arms, and in addition had a belt wheel which further weakened it to a point where, according to Kent, the joints averaged only one-fifth of the strength of the rim.

The weight of the bolt flanges was concentrated in the middle of the arc between the arms, which is a bad feature of design and may account in part for the low strength allowance. Acting on the weakest part of the rim, the weight would tend to bow outward the arc of the rim between the spokes. The force would be greater when the joint was not supported by the belt, so that there would be a varying strain to fatigue and crystallize the metal in the rim between the joint and the arm. (*Power,* vol. 48, no. 15, October 8, 1918, pp. 516-519, 6 figs., *d*)

THE RELATION OF SCREW-THREAD ANGLES TO OTHER FUNCTIONS, H. J. Bingham Powell. The writer advocates the adoption of the Whitworth form of thread as an international standard.

The radius of the Whitworth screw is said to come under the designation of a "natural" one, because many years of experience in making it show that it has about the least radius at which the tool will maintain a stable cutting point. In fact, the writer states that even in the United States he has found

the same to be true from investigations on the radii of the roots of the U. S. standard form of bolts cut by dies which were nominally supposed to have a flat root. The flat top (such as used in the U. S. S. thread) is about the worst for a tool that can be imagined, as apart from the corners rapidly disappearing by abrasion, they become overheated and brittle and fall off. Thus, the rounded top and bottom for a thread are a practical necessity, while the U. S. S. flat top and bottom are impracticable and consequently hardly ever obtained in ordinary commercial work with taps and dies.

Fig. 3 shows a comparison of screw threads of various angles. In drawing up the diagrams the author gave the "natural" Whitworth rounding at the crest and root of the threads of the several angles, since that is, in his opinion, the shape they will have as made, whether the maker set out to produce the flat U. S. S. form or the rounded root of sharp radius striven for in the international type.

In fixing on a desirable thread angle the correction necessary to the pitch diameter for any error of lead in the screw must be taken very seriously into consideration. This correction is 10 per cent greater for the Whitworth, 31 per cent greater for the British Association and 43 per cent greater for the 45-deg. angle than the correction necessary for a 60-deg. thread. This increase for the 45-deg. angles is so large as to make this angle impracticable.

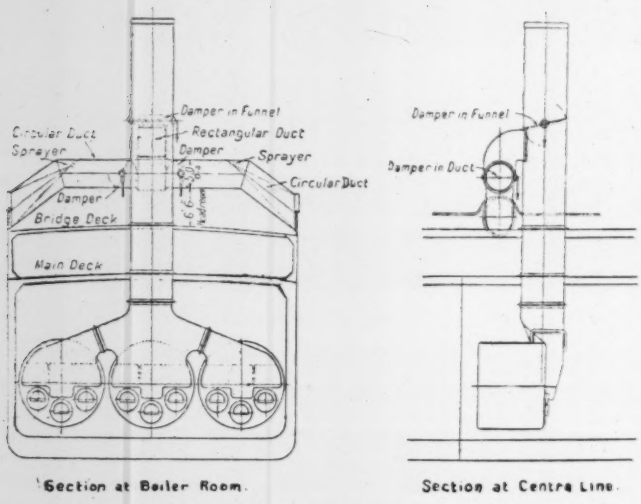


FIG. 4 DUCT AND DAMPER ARRANGEMENT OF THE YARROW ANTI-SUBMARINE SMOKE SYSTEM

The author therefore recommends for consideration as a standard international thread the Whitworth form with its "natural" rounding at the crest and root and much greater space at the root available for tolerances as compared with the U. S. S. form. (*American Machinist*, vol. 49, no. 13, September 26, 1918, pp. 571-573, 1 fig., *cg*)

Machine Shop

CASTING RINGS IN CENTRIFUGAL MACHINE, E. F. Cone. Description of new process for casting piston rings and the apparatus used therefor.

In THE JOURNAL of October 1916 (p. 831) there was described a method of making cast-iron pipe centrifugally, invented by a Brazilian engineer, D. Sensaud de Lavaud. The present process is the further development of the same method and, according to the description, is remarkable both for the extremely rapid production as compared with the labor employed and for the properties of the rings themselves. As to production, one unit with about eleven men and boys delivers 18,000 to 20,000 rings a day.

The process of manufacture is comparatively simple. It consists in introducing into a rapidly revolving permanent metal mold a definite amount of hot metal of proper composition, which is immediately thrown to the outer surface of the revolving mold. There it quickly cools and assumes its definite shape. After that the ring is removed and annealed and then the inner rim of the ring is ground on a special machine.

The casting machine and the special re-assembling machine for the molds are described in the original article. An interesting apparatus has been devised for annealing the rings. It consists of a cylinder confined or suspended perpendicularly within a large iron chamber. At a certain section it is heated to the required temperature by means of an oil burner extending inside the outer casing and playing on the cylinder, the degree of heat of the rings for annealing being regulated by a pyrometer. The diameter of the pipe is about that of the rings to be annealed, thus keeping the rings to their exact shape. The heat treatment is nearly automatic. The rings are fed in at the top and as they pass down they reach the proper temperature of 1900 deg. fahr. and finally pass out at the bottom properly annealed. It is stated that this device can treat 20 rings a minute, or about 1200 an hour.

Information on the properties of the metal in the ring is based on tests made for the inventor at Columbia University, New York. From these tests it appears that the machine-cast rings had a tensile strength of 61,400 lb. per sq. in., which may, however, have been partly due to the very small size of the specimens. The ultimate resilience in compression was found to be 19.28 in-lb. and it was further found that the machine-cast rings have a very pronounced elastic limit well below the ultimate strength, which would indicate a considerable amount of uniformity in the structure of the metal. Micrographic investigation has shown the graphite to be distributed in a fine condition and the entire crystalline formation appears to be homogeneous. (*The Iron Age*, vol. 102, no. 14, October 3, 1918, pp. 801-807, illustrated, *d*)

Marine Engineering

THE YARROW ANTI-SUBMARINE SMOKE SYSTEM. Description of a system developed for application to merchant vessels with the view to reducing the visibility of the vessel.

It has been found that a steamer with the usual type of funnel emitting a column of smoke to a height of 150 ft. would be visible to an observer on a submarine 17.4 nautical miles away. The freeboard of the steamer being taken at 33 ft., the elimination of her smoke column would result in her remaining invisible to the submarine at all distances greater than 10.17 nautical miles. This means that with the smoke column emitted in the usual way, the area within which the steamer is visible from the submarine is 950 square miles, while with the smoke column eliminated this area is reduced to 320 square miles.

As shown in Fig. 4, in the Yarrow anti-submarine smoke system means are provided for diverting the smoke and waste gases out of the funnel into a duct or ducts leading to the sides of the ship and ejecting them on to the surface of the water by means of a water spray fitted within the ducts. The object of the water spray is to cool the gases so as to cause them to fall to the sea water level instead of rising again immediately after they leave the duct, and, further, to absorb a large proportion of the solid particles of carbon in the smoke, thus reducing its blackness and therefore its visibility.

In actual use, the smoke is said never to rise above the level of the bridge, while the hot gases cause part of the water of the spray to become steam, with the result that the smoke issuing from the side ducts is quite similar in appearance to that emitted by a locomotive, and is black only for a minute or two after the furnace fires are stoked afresh.

Actual experience at sea has shown that the draft induced by the water sprays is much superior to that obtained in the usual way from the funnel, and therefore the control of the air supply to the furnace is improved.

As shown in Fig. 4, a damper is provided in the funnel and another in each of the side ducts. The handles of the dampers are interconnected in such a way that all three dampers cannot be opened at the same time. In general, it is intended that when the system is in use the funnel damper should be closed, the damper in the duct on the leeward side of the vessel opened and the damper on the other duct closed. Different conditions may, however, require a different system of operation.

The water for the sprays is supplied by a pump in the engine room capable of delivering a jet at a pressure of 180 lb. per sq. in. The sprayer when properly regulated should produce a cone of spray, the edges of which should just touch the outlet edges of the duct and also sides of duct outlet. This condition is quite important. (*The Engineer*, vol. 126, no. 3272, September 13, 1918, pp. 218-219, 8 figs., *d*)

MANUFACTURING EAGLES AT FORD'S SHIPYARD, Chas. Lundberg, Mem.Am.Soc.M.E. Description of the Ford submarine chasers and their method of manufacture as carried out in the Ford plant on the River Rouge at Detroit.

The entire plant was built in less than five months and consists of a main structure 350 ft. by 1700 ft., of steel and glass with composition roof; a fabricating shop 155 ft. by 450 ft., to which 150 ft. more is being added; a great fit-out building, a transfer table 202 ft. wide for the transverse movement of completed hulls, and a hydraulic launching machine which gently and always under full control lowers the ship into the water.

The boats are assembled in a great building, 21 of them being under construction at one time.

Each boat is assembled on a carriage supported by car wheels, there being 12 trucks, each with four wheels under each carriage. The building of the boat comprises seven groups of operations and they are so timed as to be finished simultaneously. When a ship moves out to the transfer table on its way to launching those behind it move up in position for the next set of operations. Briefly outlined, these operations are as follows:

No. 1: Keel laid and bulkhead collars placed, also some of the floor beams, part of the longitudinal bulkheads, center and inner bulkheads. (Incidental riveting, of course, is a part of each series of operations, likewise reaming rivet holes and some welding.)

No. 2: Floor built and frames (of which there are 113) erected the entire length of the boat; athwartship bulkheads, liners, keelson and floor stringers. Engine room, tank plating, platform deck beams placed fore and aft.

No. 3: Forward deck plating, outside and after-deck plating, gunwale bar and collars, main deck beams, stanchions, engine and boiler room, rudder brackets.

No. 4: Remainder of platform deck plating; bulkheads from platform to main deck, windlass and steam-engine foundations, signal room.

No. 5: Deck bars and fittings, scuttle and manholes, watertight floors and calking.

No. 6: Forward and aft deck houses, breakwater, charthouse, strut and stern bearings, bilge and drain piping, oil compartment tunnel.

No. 7: Seacock and strainer installation, steering gear and stuffing box, steering engine and anchor, ladder stairways, oil pumps, auxiliary pumps and air compressors. Installation of shaft and propeller. Riveting, welding and calking completed, all compartments air-tested, painting and inspection completed.

An interesting part of the original article is devoted to the method of handling labor. (*The Iron Age*, vol. 102, no. 12, September 19, 1918, pp. 679-684, illustrated, *d*)

Motor-Car Engineering (See also Internal-Combustion Engineering)

HEAVY-OIL-BURNING ARRANGEMENT FOR MOTOR CARS. Description of an arrangement invented by F. A. Wilkinson to burn tar oil on an ordinary automobile.

The car is started on coal gas, which may be replaced by gasoline. When the heavy oil is first switched on and after the car has been standing there is a certain amount of temporary smoke emission and the fumes from the exhaust are decidedly pungent, but the car is said to run with perfectly regular firing and to pick up well.

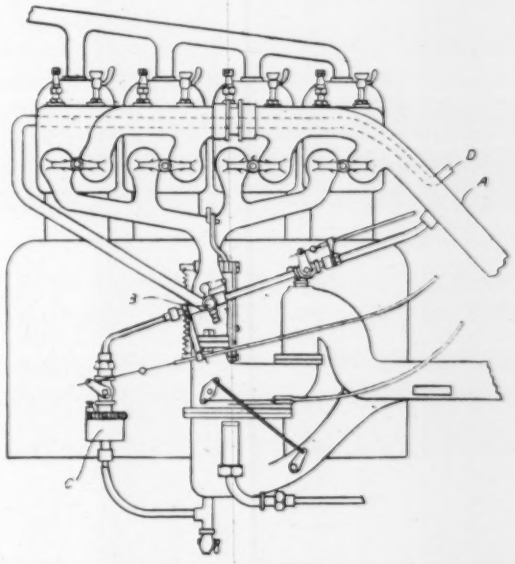


FIG. 5 WILKINSON HEAVY-OIL-BURNING ARRANGEMENT FOR MOTOR CARS

Fig. 5 shows the arrangement used. The original carburetor of the car is retained, but additional pipes are installed. The first of these is a small pipe *A* leading from the exhaust pipe and admitting exhaust gases through a valve *B* into the inlet pipe just above the carburetor. Next comes a small heating chamber *C* placed alongside the float chamber and connected thereto in such a way that the level of the fuel is the same in the two chambers. In this heating chamber is a coil of wire connected with the battery which heats up the fuel in the chamber. The air is admitted through pipe *D*, located, as shown, partly in the exhaust pipe. The hot air from *D* enters the induction pipe at right angles to the fuel rising from the jet. Hence there is admission of actual exhaust gases and of very highly heated air into the induction pipe beyond the carburetor, in addition to the warm air which normally enters the car-

buretor. (*The Engineer*, vol. 126, no. 3272, September 13, 1918, pp. 227-228, 2 figs., *d*)

Power Plants

BY-PRODUCT INSTALLATION FOR POWER STATIONS, Klingenberg. (*Zeits. Vereines Deutsch. Ing.* 62, p. 1, Jan. 5, 1918. *Elek. Zeits.* 39. pp. 176-177, May 2, 1918). The author first reviews the trend of the market for by-products. A great increase in production will cause a fall in prices and, in particular, the price of ammonium sulphate is likely to decrease owing to competition between the numerous nitrogen plants erected during the war, including those working the Haber process.

He then reviews distillation processes (coking and gas making), and deals with the erection and operation of plants for gasifying the whole of the fuel and recovering by-products. A gas of high calorific value at low temperature is required, and low temperature is needed in the producer if the tar and ammonia compounds are not to be dissociated. One of the most serious obstacles to the design of a large, high-efficiency installation is the limit of 650 to 1030 kw. obtainable from one producer unit, compared with 3000 to 5000 kw. from a steam boiler. The need of auxiliary steam supply is an important factor in the heat balance.

The author investigates in detail the relative economy of three types of power-station plant: namely, steam turbines with coal-fired boilers; steam turbines with gas-fired boilers and by-product plant; gas engines with by-product plant. In order to cover uncertainties regarding yield and price of by-products, three cases are assumed: (1) 6.44 M. per ton of coal; low yield and low prices; (2) 12 M. per ton of coal; good yield and good prices; (3) 17.56 M. per ton of coal; good yield and very high prices. Other assumptions made are: 1 to 1.5 per cent nitrogen content of coal; 68 per cent thereof recovered; 12 per cent light-load consumption of producer; 70 per cent full-load efficiency; 50 kg. tar per ton of coal; 2.2 kg. auxiliary steam per ton of coal, 0.8 kg. being raised by producer heat, 1 kg. by exhaust heat in the case of gas engines, and the rest by special boiler. The peak load of the station is assumed to be 100,000 kw., the size of the turbine units 20,800 kw. and of gas engines 6100 kw. each. The latter is relatively a higher limit than the assumed size of the turbine units, yet it involves 22 gas engines as compared with 6 turbines. The heat consumption on full load is taken to be 4360 kg-cal. per kw-hr. for steam turbines, 3570 kg-cal. for gas engines; and 13 per cent and 45 per cent of these figures on light load.

Objections to gas engines are: High total first cost; influence of gas composition; expensive attendance; repair and lubrication; vibration of foundations; small overhead capacity. Variable load involves increased heat loss and less satisfactory yield of same kw-hr. output in each case. The coal consumption of a steam-turbine plant with coal-fired boilers is exceeded in by-product plant with gas-fired boilers by 150 per cent, and with gas engines by 40 per cent. According to this, it is better to burn considerably less coal without by-product recovery than to burn much more coal in recovery plant. At least, no generalization is possible, and the economic justification for by-product recovery must be established in each particular case.

The capital costs for the three types of plant are estimated to be: Steam turbines without by-product recovery, 22.5 million M.; steam turbines with by-product recovery, 46.2 million M.; gas engines with by-product recovery, 47.6 million M. The capital burden is heavy in cases (2) and (3), but the price of coal is a more important factor with by-product recovery than without it. When the price of by-products is low, gas engines are at a disadvantage compared with steam plant, and the lower the revenue from by-products the greater the justification for direct combustion.

The author concludes that few by-product installations are economically justifiable where German hard coal (low in nitrogen) is employed. Even with medium nitrogen content it is unprofitable unless the price of tar and sulphate is well maintained. Steam turbines with by-product recovery are at an advantage compared with gas engines if the price of coal be less than 14 M. per ton. At higher coal prices, and with a by-product revenue of 10 M. per ton of coal, the field of competition of the gas engine is entered, but even then it is necessary to assume a higher load factor than can generally be realized in practice. If the by-product revenue be only 12 M. per ton, the load factor should be 60 per cent; and if the load factor be only 40 per cent, the by-product revenue should be 18 M. per ton of coal. Artificial improvement of load factor by chemical or metallurgical loads is not to be recommended if the latter could otherwise be served by water power. Direct combustion of coal is advised under any operating conditions if the revenue from by-products is less than 8 M. per ton of coal. The gasification of brown coal offers rather better possibilities than hard coal, particularly as regards the possible recovery of tar, fuel oils, and lubricating oil, but the gross saving anticipated from a quite favorable combination of circumstances does not appear to justify the commitments involved. Neither the amount of coal which could reasonably be subjected to by-product recovery, nor the revenue to be expected from such recovery, is as great as many writers have assumed. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 8, no. 248, August 31, 1918, pp. 281-283, *g*)

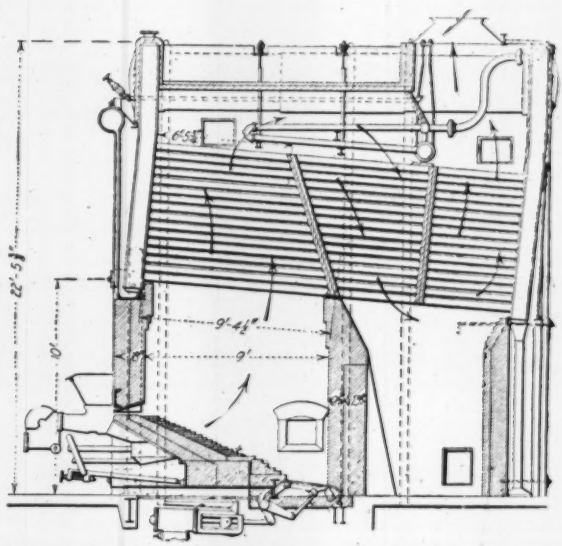


FIG. 6 SETTING FOR UNDERFEED STOKER, CEDAR RAPIDS PLANT

CEDAR RAPIDS BIG STEAM PLANT. Description of a 16,000-kw.-turbine plant giving commercial and railway service, and which in addition is selling steam for heating and also supplying large quantities of live steam for cooking. The amounts of heating steam are quite large and, for example, last January 70,000,000 lb. of steam were delivered to the heating system and the same amount of make-up had to be heated from an average temperature of 40 deg. to 210 deg. without the assistance of an economizer.

The use of so much raw water with its consequent deposits of scale and fouling of boiler tubes is one of the disadvantages under which the plant has to operate. The conditions under which the plant operates are, however, so variable that water softening is unadvisable. This variability of operating conditions makes it necessary to provide stokers which will respond to quick changes in load and will operate at considerable overload with Iowa coal. Underfeed stokers are used and the setting is as shown in Fig. 6. There the stoker is set

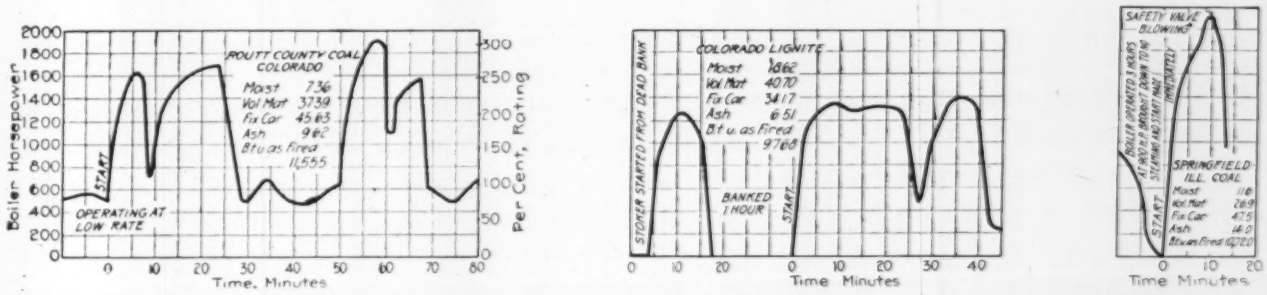


FIG. 7 FLEXIBILITY-TEST CURVES WITH STOKERS ON LOW-GRADE FUELS AT CEDAR RAPIDS PLANT

flush with the boiler front, and with straight walls front and rear the combustion space is as large as the headroom of 10 ft. will permit, the volume approximating 880 cu. ft.

Seven-retort stokers serve water-tube boilers rated at 627 hp. Operating at boiler rating, each stoker burns from 2500 to 3000 lb. of coal per hour and upon an occasion as high as 7400 lb. of coal per hour were burned, or over 1000 lb. per retort.

The three curves of Fig. 7 indicate the flexibility of operation. In the test with Colorado lignite (central figure) the stoker was started from a "dead bank." A high output was required for a short interval and then the load was taken off completely. The stoker is banked for an hour and is then called to meet a sudden and long-continued demand. The figure on the right shows a quick building up with the safety valve blowing at the top of the curve. These curves show that the stokers even when burning inferior coal will care for quick changes in load and will maintain heavy overloads at high efficiency.

In this instance the stoker engines are independent of the fan engines. The former are installed on the boiler-room floor with chain connections to lineshafts in the basement and driving chains from shaft to stoker. One engine will serve two boilers.

The electrical part of the plant is somewhat unusual in that the generation is all two-phase 2300-volt and the distribution three-phase with the exception of feeders for city service. The original article gives a single-line diagram for the two-phase, three-phase differential relays. The out-of-town service is three-phase 33,000 volts, the current being stepped up by two sets of 600-kw. two-phase three-phase transformers connected in multiple between the 2300-volt and the 33,000-volt buses.

All the high-tension lines are controlled from the operator's room equipped with means for remote control of the oil switches, as well as telephone connections to the city system and by a private line to the various stations operated by the company as well as the boiler and turbine rooms. (*Power*, vol. 48, no. 14, October 1, 1918, pp. 478-485, 12 figs. and list of principal equipment, *dA*)

NEW PLANT OF THE PENNSYLVANIA SALT MANUFACTURING COMPANY. The plant is located at Wyandotte, Mich., 12 miles from Detroit, and the addition described in the present article was laid out specifically for convenience of operation, with plenty of room to make repairs to allow for future extension without disarranging the present layout.

The boiler room has been made the prime factor of the plant, and has an equipment consisting of modern types of water-tube boilers, underfeed stokers and economizers.

An interesting feature of the plant is the centering of the control of all boiler-room auxiliaries in an operating board, on which are also grouped a variety of instruments (indicating and recording) giving all information necessary for the efficient operation of the plant.

In the main feed line to the boilers there is a venturi tube with a manometer, and also a thermometer to measure the feedwater, the instruments being located on the operating board. On the board there is also a steam-flow meter for each boiler. The latter instruments show the output in each case, and the aggregate readings may be checked against the total input shown by the water meter in the supply line.

The control of the dampers is also centered on the operating board. In this board there are six panels, one for each boiler. These panels contain the handwheels to the dampers in the breeching and in the forced-draft inlets, a steam-flow meter and draft gages showing the draft over the fire and in the last pass of the boiler, and the pressure under the stokers. One panel contains, in addition to the flow meter on the feedwater referred to above, a pyrometer and multiple switch, draft gages showing the draft on the stack side of the economizers and the handwheels for controlling the vertical dampers at the economizer outlets. The last panel has two large dial gages showing the pressures at the turbine throttles, in addition to which there are the three field rheostats and ammeters for the forced-draft fans and the stoker motors.

At the side of the operating board there is a recording-gage panel containing four pressure-recording gages, two of which give the pressure at the turbine throttles and the other two record the pressure on the feedwater system, one before the economizers and the other at the delivery to the boilers.

One recording thermometer charts the temperature of the water entering the boilers and another the temperature of the water entering the economizers, in addition to which each battery is served by a CO_2 recorder.

The above constitutes an unusually complete set of apparatus and affords a good basis toward efficient operation of the plant.

Another feature of interest in the plant is the use of three eductor-type jet condensers (Fig. 8) taking the exhaust steam from the auxiliaries and the condensate from the main condensers. The latter at a temperature approximating 90 deg. is forced through the jet condensers, where its temperature is raised by the auxiliary exhaust to about 150 deg., which is considered to be the most economical temperature for the economizer.

The condensers are connected in parallel, and any number of them may be operated at one time, or the condensate may be bypassed directly to the hotwell. (*Power*, vol. 48, no. 12, September 17, 1918, pp. 406-413, 10 figs., *da*)

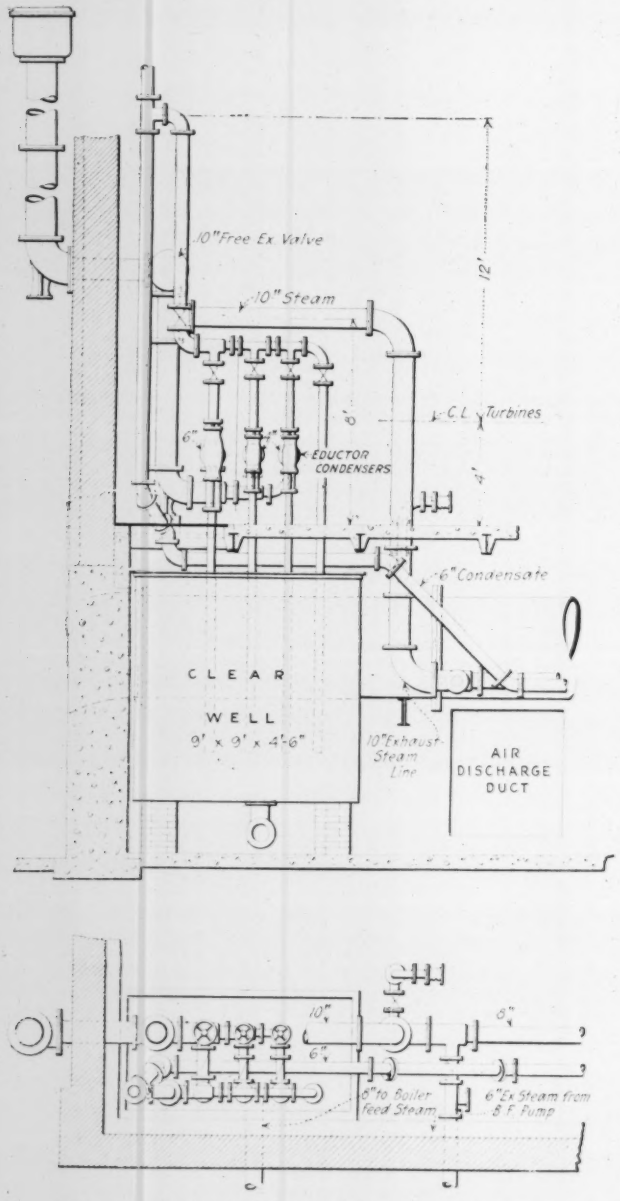


FIG. 8 ARRANGEMENT OF EDUCTOR CONDENSERS

Railroad Engineering

RENEWABLE STAY HEADS FOR LOCOMOTIVE FIREBOXES. Data of experiments by Mr. Snelson, Chief Foreman Boilermaker, in the Locomotive Works at Crewe, England. This led to the development of a new method of repairing locomotive firebox stays recently adopted on the London and Northwestern Railway Company's lines.

Fig. 9 gives a plan and elevation of one of these heads for insertion, and also shows the head in position. It is to be used chiefly for renewing small or defective stay heads. The small and defective stay head is hammered up in order completely to expand it in the hole. It is then centered, drilled and tapped to a depth of about $\frac{5}{8}$ in. for the front side of the plate. The stay end and firebox plate are then lightly skimmed up with the facing cutter. This facing cutter, which is equal in diameter to the new head, is screwed into the tapped hole to insure obtaining a face that is perfectly true with the hole. By this operation the stay is made ready for the new head. A thin copper washer is then inserted between the face of the new head and the copper stay, and the head is tightly screwed in by means of a wrench on the square end.

The heads have been tested in several instances, described in the original article and showed up quite well. Among other things, there was some uncertainty to whether the repaired stay would be strong enough to withstand the various stresses set up in the firebox. Fracture tests were, therefore, carried out in the testing department at Crewe, and it was found that even on the smaller stays there is a good factor of safety. Thus, a 1-in. stay fitted with the head of the new type in a boiler working at 150 lb. pressure per sq. in. has a factor of safety between 6.5 and 7 when the stays are pitched 4 in. apart, while on stays $1\frac{3}{16}$ in. and $1\frac{1}{4}$ in. in diameter and upward, the net section of the repaired stay is greater, and consequently stronger than the original 1-in. or $1\frac{1}{16}$-in. stay.

Various instances are cited in the original article to show

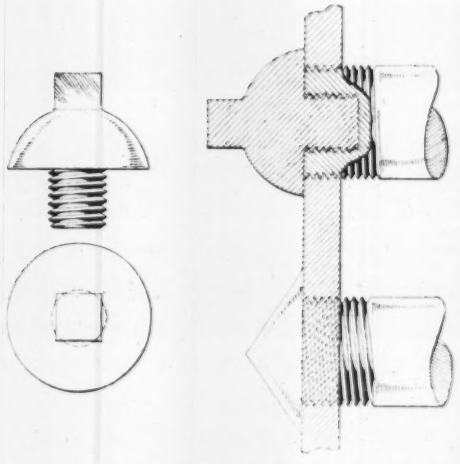


FIG. 9 SNELSON RENEWABLE STAY HEAD FOR LOCOMOTIVE FIREBOX

the durability of the new type of head. Thus in one case 21 of these heads were put in the firebox sides of a loco-stationary boiler in December 1916. Since then it has been worked continuously night and day, week ends and holidays excepted, and up to the present time not one head has given the slightest trouble. Early in October 1917 this boiler was stopped for cleaning, and advantage was taken of this stoppage to take one of the heads out for inspection purposes. It was found that in outline the form of the head was practically unchanged, even the square portion being in such good condition that it was used to withdraw the head, as it was used 10 months before to insert it.

The copper liner that had been threaded on the head was intact and the copper plate underneath the head was in splendid condition. (*The Engineer*, vol. 126, no. 3270, August 30, 1918, pp. 176-177, 5 figs., *d*)

Refrigeration

THROTTLING OF AMMONIA, Chas. D. Herter. From time to time the question has been raised whether during a shortage of ammonia any disadvantage might result if, instead of regulating several expansion valves singly, the main liquid valve (also known as the king valve) at the liquid receiver was throttled down so as to obtain at once the desired reduced feed in liquid to the refrigerating coils.

The writer comes to the conclusion that intermediate throttling of liquid is entirely proper under certain conditions, the only possible harm being more rapid wear of the valves used. From a thermodynamic viewpoint no noticeable benefit is obtained by reducing the pressure upon the liquid gradually instead of all at once, while the provision of an emergency feed valve, in addition to the main liquid valve ordinarily left fully open, is considered good practice. (*Power*, vol. 48, no. 15, October 8, 1918, pp. 530-531, *p*)

Steam Engineering

PUMPING ENGINES FOR THE CAIRO MAIN DRAINAGE. Description of the engines used in the new main drainage system of the City of Cairo, in Egypt. This machinery consists briefly of four sets of pumping engines each driving direct from the engine crossheads a set of triplex single-acting plunger pumps.

The pumping engines themselves may be described as being of the inverted vertical quadruple-expansion three-crank type having the high and first intermediate cylinders placed tandem over the center crank and the second intermediate and low-pressure cylinders placed one on either side of the first intermediate cylinder and over the outer cranks.

The chief point of interest lies in the arrangement of the high and first intermediate cylinders, which, as shown in Fig. 10, are single-acting. In fact, the arrangement is equivalent to one double-acting cylinder as far as the number of valves and amount of valve gear are concerned, with the advantage of a reduced temperature range with each cylinder.

The pistons of the two cylinders are in one piece forming what may be called a differential piston. The upper part of this piston is in plunger form and fills the high-pressure cylinder for the whole length of the stroke, thus preventing the cooling of the high-pressure cylinder walls by contact with the lower-temperature steam content in the annular space in the upper part of the first intermediate cylinder. The following advantages are claimed for such an arrangement as compared with the more usual plan of providing two superimposed double-acting cylinders: In the first place, there is a material reduction in the number of valves and their consequent working parts with a corresponding reduction in steam leakage. There is also a reduction in the overall height of the engine and, in addition, a simple and secure base is obtained for the high-pressure cylinder. Further, the gland and stuffing box on the high-pressure cylinder, which the usual double-acting construction would require, and which would tend to be a source of trouble, are eliminated.

The steam cylinders are, respectively, 17 in., 27 in., 33 in. and 49 in. in diameter with a common stroke of 36 in., and when running at normal speed of 22 r.p.m. each engine is capable of developing 200 hp.

All of the valves are actuated by a lay shaft carried along the front of the cylinders and rotated at the same speed as the crankshaft with skew gearing on a vertical shaft reaching from the crankshaft to the valve-motion lay shaft. By the use of this lay shaft heavy eccentrics, rods, and rocking levers are dispensed with. The steam valves of all cylinders are fitted with the trip motion giving practically instantaneous closing, the shock of the drop valves being absorbed by oil-cataract dashpots to insure silent working, while the Corliss valves are controlled by spring dashpots of the usual type. The exhaust valves are controlled throughout by positive-motion gear.

Owing to the type of link mechanism adopted for actuating the valves, the distortion due to obliquity of the usual eccentric gear is practically non-existent; this was found to be a distinct advantage in adjusting the valve motion relatively to the actual working steam pressures, in view of the somewhat unusual differences in pressure between the upper and lower ends of the two final cylinders, due to the fact of the first two cylinders being single-acting. In order to equalize the pressures, and avoid the loss due to "drop" between succeeding cylinders, reheater receivers of ample proportion are provided. These are fitted with solid-drawn steel tubes, and are coupled to the jacket system, so that steam at initial pressure and temperature is continually circulated through the tubes, thereby drying and reheating the working steam on its passage to the succeeding cylinder. (*Engineering*, vol. 106, no. 2749, September 6, 1918, pp. 251-252 and one plate of drawings, *d*)

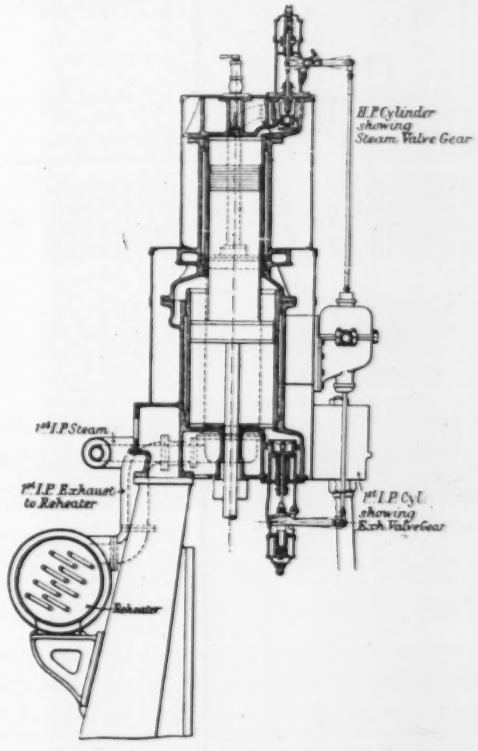


FIG. 10 HIGH AND FIRST INTERMEDIATE CYLINDERS OF THE PUMPING ENGINES FOR THE CAIRO MAIN DRAINAGE

A NEW THEORY OF THE STEAM TURBINE, Harold Medway Martin. Continuation of abstract of a serial article. Previous installments of the abstract appeared in THE JOURNAL, September 1918, page 784, and October, page 871.

In the previous article it was shown that adiabatic heat drop cannot under all conditions be taken as proportional to the actual effective thermodynamic head and that where the superheat is high the reheat factor is also high and vice versa.

In the present article the author shows how to determine the point at which different degrees of initial superheat are lost.

Assume for example that the initial pressure is 180 lb. absolute and that the hydraulic efficiency of the turbine is 70 per cent. Suppose the superheat to be lost at, say, 80 deg. cent. The volume of the steam is then 54.596 cu. ft. per lb. (Callendar) and its pressure is 6.8627 lb. per sq. in.

The initial pressure being 180 lb. absolute, we have

$$x = \frac{p_1}{p_2} = \frac{180}{6.8627}$$

If ρ be the ratio of the final volume to the initial volume then, since the expansion follows the law $pV^m = \text{constant}$ (where $m = \lambda$), we have $\rho = x^{1/m}$

The value of $1/m$ is given (p. 53 ante) by the relation

$$\frac{1}{\lambda} = 1 - 0.23077\ \eta = 1 - 0.23077 \times 0.7 = 0.8385$$

Whence

$$\rho = \left[\frac{180}{6.8627}\right]^{0.8385} \quad \text{and} \quad V_s = \frac{V_2}{\rho} = 3.528 \text{ cu. ft. per lb.}$$

Reference to Callendar's table shows that steam at 180 lb. absolute with this specific volume has a temperature of 331.6 deg. cent., corresponding to a superheat of 142.1 deg. cent. or 255.8 deg. fahr. By determining a number of values in this way and plotting the results as curves, the temperature at which any stated initial superheat is lost can be determined. The writer gives a table showing the approximate temperatures in centigrade at which superheat is lost for different hydraulic efficiencies when the initial pressure is 180 lb. absolute. With the temperatures given in such a table it is possible to calculate the total effective thermodynamic head, or, to

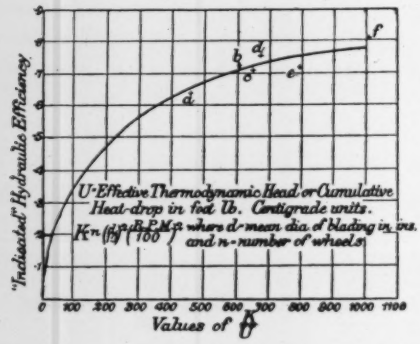

"Indicated" Hydraulic Efficiency
U-Effective Thermodynamic Head or Cumulative Heat-drop in Fed. lb. Centigrade units.
Values of U

FIG. 11 "INDICATED" HYDRAULIC EFFICIENCY OF IMPULSE TURBINES IF STEAM EXPANDS IN THERMAL EQUILIBRIUM THROUGHOUT

use Professor Goudie's terms, the cumulative heat which becomes available in a turbine when expanding steam from 180 lb. absolute to 1 lb. absolute with different hydraulic efficiencies, the steam being supposed to be in thermal equilibrium throughout. The author gives a table of cumulative available heats when steam expands in thermal equilibrium from an initial absolute pressure of 180 lb. per sq. in. to 1 lb. absolute with different hydraulic efficiencies and different initial superheats. This table

TABLE 1 CUMULATIVE AVAILABLE HEATS F. P. C. WHEN STEAM EXPANDS IN THERMAL EQUILIBRIUM FROM AN INITIAL ABSOLUTE PRESSURE OF 180 LB. PER SQ. IN. TO 1 LB. ABSOLUTE; WITH DIFFERENT HYDRAULIC EFFICIENCIES AND DIFFERENT INITIAL SUPERHEATS

Hydraulic Efficiency η	Initial Superheats, Deg. Fahr.						
	0	50	100	150	200	250	300
0.5	201.3	207.2	216.2	226.9	238.9	251.1	262.4
0.6	197.4	203.5	210.3	219.4	229.6	240.4	251.4
0.7	194.1	199.2	206.7	214.2	222.6	232.9	241.3
0.8	190.7	196.3	202.5	209.3	216.9	228.5	233.6
1.0	184.1	189.5	195.4	201.7	208.2	215.0	222.0

is here reproduced as Table 1. To determine from this table the theoretical steam rate for a turbine working with different superheats a correction is required because increases in the effective thermodynamic head change the ratio of blade speed to steam speed.

This correction can be effected by means of the curve plotted in Fig. 11 on the assumption that thermal equilibrium was maintained throughout the whole expansion. In this curve the "indicated" hydraulic efficiency of a number of impulse turbines is plotted against K/U, where

$$K = n\left(\frac{d}{10}\right)^2\left(\frac{\text{R.P.M.}}{100}\right)^2$$

and U denotes Ru, where u is the adiabatic heat drop. In the above expression for K, the number of stages is represented by n, while d denotes the mean diameter of the lading. Since the average velocity of the steam is proportional to $\sqrt{(U/n)}$, the expression $\sqrt{(K/U)}$ is proportional to the ratio of blade speed to steam speed. According to the ordinary view the indicated hydraulic efficiency should give a parabola when plotted against $\sqrt{(K/U)}$, and consequently the curve in Fig. 11 should be an ellipse. The points lie badly on an ellipse, however, and the curve shown has been sketched in freehand. As will be shown later, a much better agreement between the curve and the experimental figures is obtained when the theory that the steam expands in thermal equilibrium is abandoned. (*Engineering*, vol. 106, no. 2744, August 2, 1918, pp. 107-108, abstract to be continued, *tA*)

GRAPHIC METHOD OF DETERMINING SIZE OF SAFETY VALVES, H. F. Jauss. The writer gives a simple method of determining the proper size of safety valve for a steam boiler. This method is based on the rules set forth in the A.S.M.E. Boiler Code, with a modification in the maximum allowable lifts, which have been increased 25 per cent above those given in the Code. The reasons for this increase are: (1) That it is possible to manufacture successfully safety-valve springs capable of these

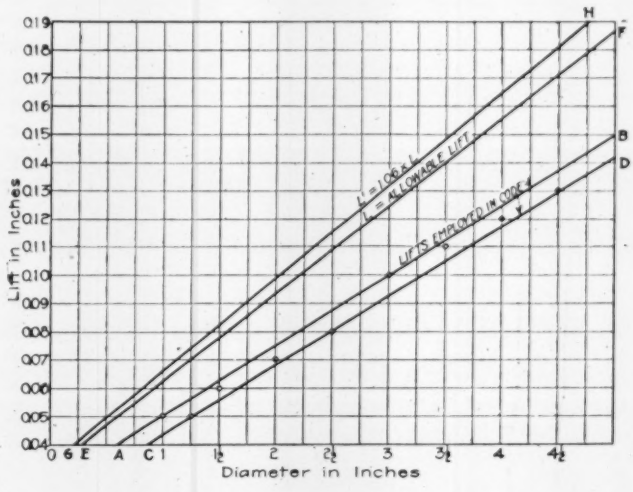


FIG. 12 RELATION OF LIFT OF VALVE TO DIAMETER

higher lifts; (2) that this decreases the number and size of valves required; (3) that the large margin of safety secured by restricting the maximum lifts to very low values as in the A.S.M.E. Code is not necessary, since at best the safety valve can only take care of a gradual increase in pressure and does not protect against a sudden increase.

The writer derives the chart in Fig. 12, where the lines *AB* and *CD* indicate the limits of the maximum lifts employed in constructing the safety-valve tables in the A.S.M.E. Boiler Code where the constant lift is employed for each size of valve regardless of the pressure. Assuming that lifts 25 per cent greater than the A.S.M.E. maximum are possible, it is easy to determine a new line *EF* indicating the maximum possible lifts for valves of various diameters.

For the construction of capacity curves, the writer uses the modified Napier's formula and also gives an alignment chart for finding the size of safety valves. A numerical example is given and fully worked out. (*Power*, vol. 48, no. 12, September 17, 1918, pp. 414-417, 3 figs., *g*)

TESTS ON STEAM-ENGINE GOVERNING, Prof. Anton Gramberg. The following tests were carried out for the purpose of elucidating the phenomena occurring when engines are automatically governed. They were carried out with a horizontal steam engine working non-condensing. The engine was equipped on the high-pressure cylinder with the so-called old Collmann valve gear regulated by a governor in the usual manner, the governor being driven as shown in Fig. 13. The position of the sleeve can be read at *r*.

The weight of the governor was 108 kg. The additional weights shown in Fig. 13 are not included in this weight.

As a rule, during the tests the governor was equipped only with the running weights displaced horizontally by hand, and so arranged as to change the speed of the engine roughly from 120 to 135 r.p.m.

In addition to this, for the purpose of experiment, there was added to the governor shaft a spindle on which the weights I and II could be located at definite intervals above and below the governor shaft. When this spindle is exactly vertical these weights exercise no effort either on the governor shaft or on the governor itself, and the spindle is in such a vertical position when the governor sleeve and the governor shaft are in exactly central position; but if the governor shaft moves out, these additional weights very rapidly create increasing moments on the governor shaft and, hence, with equal rapidity, increasing forces on the governor sleeve. These forces pass from negative values through zero to positive values (counting them algebraically in the same sense all the time) and their increase is approximately proportional to the paths traveled by the governor sleeve, the speed of the rise being approximately proportional to the distance either above or below the weights from the governor shaft.

One can investigate the action of these variable weights (which can be displaced either in the horizontal or in the vertical direction) on the governing by varying the electrical load N_{el} on the machine, so that the governor will assume various positions for r and then by observing the corresponding speeds n.

In these tests the horizontal weight was displaced first. It weighed 18.15 kg. (40 lb.) and was displaced from its normal position to the left to a distance of 0.1 m. (3.94 in.) and then shifted through a distance of 0.2 m. (7.87 in.) entirely to the right. The arm of the governor shaft, on which the force acting on the sleeve was applied was 0.141 m. (5.56 in.), therefore the displacement of the weight exerted additional forces on the sleeve equal to $18.15 \times \frac{0.1}{0.141} = 12.9$ kg. (28.4 lb.) or $18.15 \times \frac{0.2}{0.141} = 25.8$ kg. (56.8 lb.), respectively. When the output of the engine was made to vary, the readings were such as shown in Fig. 14. For the two end positions and the middle position of the governor weights there were obtained the three rising characteristic curves of governing parallel to each other.

It appears, therefore, that the horizontal displacement of the weights caused the characteristic curve of governing to shift to the right, but did not produce its turning. It affects the speed of rotation but not the degree of lack of uniformity of governing.

The behavior of the curves of equal output N_{el} (Fig. 14) of the steam-engine generator set is also of interest. At higher speeds a smaller torque corresponds to the increased output, and therefore one would expect a higher position of the governor. This is what actually occurs at all loads, but not when the set is running idle. In this latter case the internal resistances of the set determine what happens, and these play only a very minor rôle at higher loads. Now, the moment of the internal resistances increases with the speed of rotation, and therefore when the set is running idle the governor goes

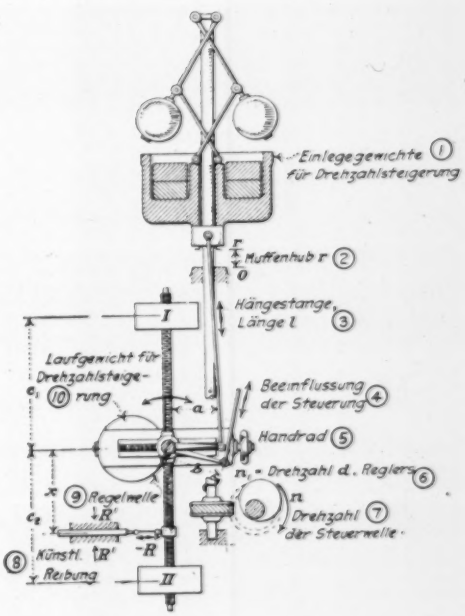


FIG. 13 DIAGRAMMATIC SKETCH OF THE EXPERIMENTAL GOVERNOR INSTALLATION

(1) Additional weights for raising the speed of rotation of the governor; (2) Sleeve travel *r*; (3) Connecting rod, length *l*; (4) Valve-gear control; (5) Handwheel; (6) n_1 = r.p.m. of governor; (7) n = r.p.m. of the layshaft; (8) Artificial friction; (9) Governor shaft; (10) Weights for varying the speed of rotation of the governor.

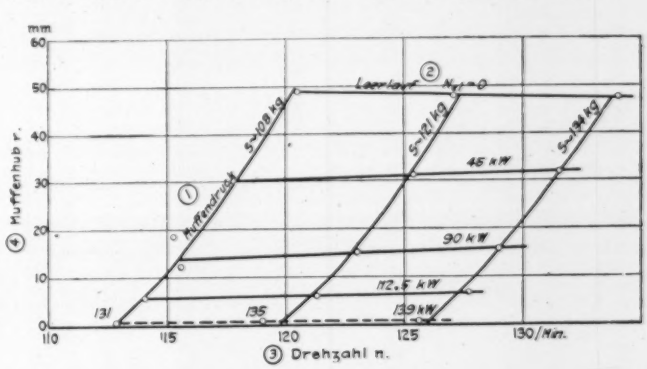


FIG. 14 CHARACTERISTIC CURVES OF ENGINE GOVERNING AT VARIABLE SPEEDS

(1) Sleeve pressure; (2) No-load operation; (3) Speed of rotation, *n* r.p.m.; (4) Sleeve travel.

down with the increase of speed; more steam when the set is running idle means a higher rate of speed on the engine.

If the weights be shifted in the vertical direction, the curves obtained will be those shown in Fig. 15. In that case the governor was first in its usual position. Next, the weight of 20 kg. (44.0 lb.) was placed 0.3 m. (11.8 in.) below the governor shaft, this corresponding to an addition of a product of forces × arm (this latter considered as being horizontal) = —6 m-kg. In the three instances the weight of 10 kg. (22.0 lb.) was lo-

cated 0.3 m. (11.8 in.) above the governor shaft, giving an additional moment of + 3 m-kg.

Under the influence of these additional weights the characteristic curves of governing undergo a rotation without displacement. They become steeper when the weight is located above the axis of governing and the governing itself tends to become astatic. On the contrary, when the weight is located under the governor axis, the characteristic curve becomes flatter and the regulation assumes a strongly static condition. The average speed of rotation of the engine is maintained, but the degree of lack of uniformity varies. When the weight is located below the axis it tends to pull the governor into its middle position, which makes greater variations in speed necessary in order to permit it to resume its end position. On the contrary, weights located above the governor axis push the

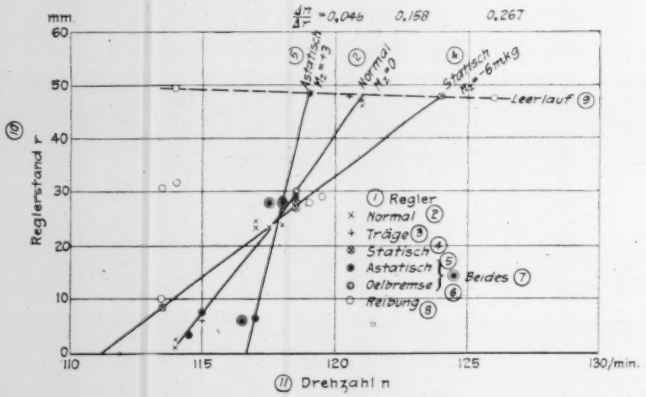


FIG. 15 CHARACTERISTIC CURVES OF ENGINE GOVERNING AT VARIABLE STATIC CONDITIONS AND VARIABLE STEAM DELIVERIES

(1) Governor; (2) Normal; (3) Sluggish; (4) Static; (5) Astatic; (6) Oil brake; (7) Both; (8) Friction; (9) No-load operation; (10) Position of governor r; (11) Speed of rotation, n r.p.m.

governor into its end position, so that only slighter variations of the speed of rotation become necessary.

In connection with Fig. 15, if weights of 10 kg. (22.04 lb.) be located 0.32 m. (12.59 in.) both below and above the governor shaft, neither the speed of rotation nor the degree of lack of uniformity of the governing will be affected. The mass of the governor is increased and the governor itself made more sluggish. The points "sluggish" and "normal" lie close to each other in Fig. 15, although the mass of the governor is increased by $20 \times (0.32/0.141)^2 = 103$ kg., which is considerable in comparison with the original governor mass of 130 deg. But the mass as such (that is, when it is equalized and does not come into action as a weight) has no influence on the static behavior of the governing.

Fig. 15 presents data of a further series of tests in which the motion of the governor was first subjected to damping artificially and next to molecular damping. The method by which mechanical damping was produced is shown in Fig. 13. As shown in the lower left corner of that figure, two cheeks are rubbing with a force R' (which can be adjustably varied) against a central piece drawn back and forth between the cheeks by the motion of the governor. Molecular damping is produced by an oil brake displacing this frictional damping. Fundamentally, the two arrangements are different in that in the case of an oil brake the damping force increases (by a law approaching the square law) as the velocity, and, what is more important, it converges toward zero along with the velocity. In the case of the mechanical damping device the damping force is practically independent of the velocity and is equally large when at rest. This, however, is not new.

Hence, in Fig. 15 the points, even with the oil brake in operation, lie in a regular manner, while the point of rest is not affected by the oil brake. On the other hand, the frictional damping produces a broad scattering of the point of rest of the governing and thus shows permanent irregularities.

All the above had a bearing on the question of the manner in which the speed of rotation n and the governor position r came to a permanent state under the influence of the governing properties of the governor. From this the author proceeds to an investigation of the manner in which the governor effects a passage from one position to another. This part of the article is quite extensive, illustrated by numerous curves, and is not suitable for abstracting. (*Versuche an einer Dampfmaschinenreglung*, Prof. Anton Gramberg, *Dinglers Polytechnisches Journal*, vol. 333, no. 4, February 23, 1918, pp. 25-30, 6 figs. *e*)

Testing

TESTING THE RELATIVE MERITS OF CASE-HARDENING MATERIALS, Chas. N. Underwood, Mem.Am.Soc.M.E. Case hardening may be said to consist of two parts: the first, carburizing the steel shell about the low-carbon soft steel; and the second, hardening this carburized shell by quenching when at a high heat. The second element is easily controlled and the problem is therefore only to find a case-hardening material best apt to give up its carbon to the steel. A test of such a material resolves, therefore, into finding a material which will give the deepest, densest and most uniform case under constant conditions of time, temperature, packing and quenching.

The present article describes the method of testing employed by the Remington Typewriter Works. The test pieces, 3½ in. long and 1 1/16 in. in diameter, were cut from a bar of round, bright machine-screw steel and packed in boxes, two pieces in each box. The box was completely filled with the case-

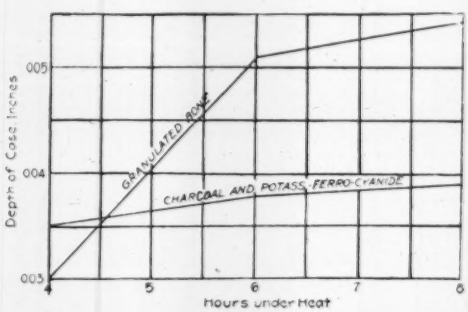


FIG. 16 RESULTS OF TESTS ON CASE-HARDENING MATERIALS

hardening material and the cover sealed with fireclay. Three boxes were packed with each kind of material, the materials tested being charcoal and potassium ferrocyanide, and granulated bone.

Special attention was paid to the proper location of the boxes in the furnace. The boxes were placed in rows and one row was removed from the furnace after four hours, one row after six hours, and one row after eight hours. As each box was removed the test pieces were taken out and quenched in cold water and the test numbers checked to insure the accuracy of the record. A log of the furnace temperatures was kept throughout the test. From this log it appears that after the specimens were placed in the furnace the temperature was raised until it reached 1800 deg. fahr. about one hour later.

The temperature was then cut down to, and held at, approximately, 1600 deg. fahr.

After hardening the test pieces were taken to the grinding

room and a groove was ground through the case completely around the circumference at about the center of the piece. The pieces were then sawed into two parts at the groove and the cut end of one of the pieces ground flat, highly polished with very fine emery and etched with a 20 per cent solution of nitric acid. Two lines perpendicular to one another were then scribed on this polished surface by means of a fine needle set in a steel holder, the depth of these lines, to a certain extent, indicating the hardness of the case. The original article describes, in some detail, the method of measuring the depth of case.

Fig. 16 gives the plotted results of measurements with the two case-hardening materials, which indicate that for a four-hour run the charcoal mixture gave a deeper case, but for longer runs granulated bone appeared to be more efficient. With both materials, however, the depth of case increased steadily up to a period of six hours, further increase of depth being at a much slower rate. (*American Machinist*, vol. 49, no. 13, September 26, 1918, pp. 569-571, 3 figs., *ep*)

TELESCOPIC FOCUSING APPARATUS FOR PHOTOMICROGRAPHY, A. F. Hallimond. There are certain difficulties in using an ordinary vertical camera in connection with the microscope. When the plate is supported at a distance of 10 in. or more above the microscope the height of the focusing screen often becomes the source of much inconvenience. Oscillation of the camera at opening of the dark slide is also troublesome.

To obviate these difficulties the telescopic arrangement described and illustrated in the present paper was designed. It resembles the ordinary form of reflex focusing camera. The rays proceeding from the microscope eyepiece which would normally converge to a focus on the photographic plate are reflected horizontally by a movable mirror. This mirror is attached to a metal plate large enough to cut off all light from the camera when in proper position and is held there by an adjustable stop. The deflected beam is focused by the telescope objective with the focal length of 4 in. upon cross-wires and the image so formed is seen together with the cross-wires when examined through the eye lens having a focal length of ¾ in.

To each length of camera there corresponds a fixed position of the focus to which the cross-wires must be set, but after this graduation has once been made it is sufficient in taking a photograph to fix the telescope for the proper camera length and focus the microscope so that the image is clearly defined on the cross-wires. The apparatus appears to be quite simple. (Paper before the September Meeting of the *Iron and Steel Institute*, abstracted through advance copy, 3 pp., 1 fig., *d*)

SHIP STRAIN RECORDER. A new device to record the "give" of a ship has been developed by F. R. McMillan, research engineer of the Concrete Ship Section, and H. S. Loeffler, assistant research engineer of the Section.

When equipped with this device, every strain that a ship experiences in a storm or, for that matter, in any weather, is recorded by little zigzag waves on a strip of paper which passes under a recording needle in the instrument. The apparatus was tried out on the concrete steamer *Faith* on her first voyage.

The "Strainagraph" is built somewhat on the principle of the seismograph. It may be destined to play an important part in future ship designing, for it gives a simple medium for comparison of the relative strength of different types of ships. Numbers of these instruments, placed in different parts of the ship, would show any weaknesses and give the expert a workable chart upon which to build an analysis or "diagnosis" of a ship's seaworthiness.

Primarily the instrument was designed to test out the qualities of the concrete ship just now passing from the experimental stage.

The strainagraph is attached at any point in a ship where it is desired to know the strain. A series of levers which multiply 140 times any movement transmitted to them is actuated by a plunger bar fixed to the ship at a point 40 in. distant. Thus the distance recorded on the chart is 5600 times the actual movement in any one inch of length.

The chart showing the record has a line at the top with breaks at intervals. Attached to the instrument is a clock which serves to measure on the chart the time during which the record is produced. Every double break in the top line marks the end of a minute and every single break the passing of a quarter of a minute.

The recording pen which records the zigzag line in the center of the chart travels upward when recording compression and downward when recording extension.

The instrument on the *Faith* was located amidships on a longitudinal deck beam about midway between hatches 2 and 3 on a line along the port side of these hatchways. (*Emergency Fleet News*, October 3, 1918, p. 13)

Varia

MAST TURNING LATHE. The Traylor Shipbuilding Corporation, Cornwells Heights, Pa., has in operation in its yard a mast turning lathe that is one of the new developments in shipbuilding since the Emergency Fleet Corporation was created. Formerly the making of masts was a long and laborious operation fit for the best work of especially skilled men. The machine will handle timbers for a mast up to 100 ft. long and 3 ft. in diameter. The timber, after being centered and set up in the machine, which usually requires about half a day, is revolved at a speed of 50 r.p.m., by means of an electric motor, thus coming in contact with the cutter head, which is mounted on a carriage attached to the motor, and set at right angles to the mast. The cutter head revolves at a speed of 700 r.p.m. In this head are three hooked knives, which cut the material from the mast.

The carriage is propelled by a wire rope on a gypsy head, which also is run by a motor, the feed of the carriage being practically the same as on an old-fashioned sawmill.

When a mast is extra long and sags in the middle, it is necessary to put a steady rest at the point where the sag is greatest, thereby making the timber run true. To get the shape of the mast, that is, the taper at the top, it is necessary to set a rail which is bolted down to the bed of the machine and bent in exact position as the profile of the mast which is to be cut. On this rail runs a shoe, controlling the cross-movement of the carriage. If the rail is set away from the machine, it pulls the carriage closer to the center of the mast. If it is set nearer it moves the carriage further away. (*Emergency Fleet News*, Oct. 3, 1918, p. 12, *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Ships for Foreign Trade

The Shipping Board is already taking cognizance of the opportunities and possibilities of trade development through the increase of the merchant marine of the United States. The following letter from Chairman Hurley of the Shipping Board has been sent to the Society:

TO THE SECRETARY:

The time has come for Americans everywhere to put themselves solidly behind American ships.

Our railroads must no longer stop at the ocean. We are building an American merchant fleet of twenty-five million tons—three thousand ships. We are backing modern ships with modern port facilities, establishing our bunkering stations all over the globe and will operate with American railroad efficiency. We will carry American cargoes at rates corresponding to our railroad rates—the cheapest in the world. Fast American passenger-and-cargo liners will run regularly to every port in Latin America, the Orient, Africa, Australia.

Are your members taking steps to use these ships to increase their own prosperity? Do they realize that American products of factory, farm and mine can be delivered to customers in foreign countries on terms which will build lasting trade? Do they realize the possibilities for bringing back raw materials to extend their products and trade?

We must all take off our coats and work to bring these American ships home to the people of every American interest and community. The manufacturer must think of customers in Latin America as being as accessible as those in the next state. The farmer must visualize ships carrying his wheat, cotton, breeding animals, dairy products and fruit to new world markets. The American boy must think of ships and foreign countries when he chooses a calling.

Has your organization appointed a live committee on Merchant Marine? Is the chairman of this committee a man of international vision? Are you applying the new world vision to the interests represented in your organization and learning what ships can do toward widening their markets?

Public neglect ruined our old mercantile marine. Congress was not to blame—it simply reflected the indifference toward ships of the average American. Once more we have a real American merchant fleet under way, backed by far-reaching policies for efficient operation. We must dispel indifference and keep our flag on the trade routes of the world. We are going to take trade from no other nation. But we must serve our own customers and help other nations in their ocean-transportation problems after the war.

EDWARD N. HURLEY, *Chairman*,
United States Shipping Board.

Washington, D. C.

Recent Improvements in the Manufacture of 85 Per Cent Magnesia Insulation

TO THE EDITOR:

It has frequently been brought to the writer's attention that the results published in his paper entitled The Heat-Insulating Properties of Commercial Steam-Pipe Coverings are not fair to J-M 85 Per Cent Magnesia because of the fact that the samples tested were not representative of the J-M 85 Per Cent Magnesia manufactured at the time the paper was published and since that time.

The samples were taken from a stock where they had been stored for a considerable period, and in the interval between the time they were manufactured and the time the paper was published very important improvements had been made in the process of manufacturing. The writer has had excellent opportunities to observe the effect of this improvement in manufacture since he became associated with the H. W. Johns-Manville Company in the capacity of consulting engineer.

However, the new material was tested by the writer at the University of Wisconsin several months before he became connected with the H. W. Johns-Manville Company and the results given below are quoted from the report of that test. The test was made by identically the same methods and on the same apparatus as the test previously reported in the writer's paper. Furthermore, subsequent tests have checked very closely with the test of the new Magnesia here given, which fact shows that a uniformly better product has been developed.

"The test of J-M 85 Per Cent Magnesia, results of which are given in Trans.Am.Soc.M.E., Vol. 37, pp. 944, 946 and 958, was made in November 1914 and the sample was taken from the stock at the University Heating Station, where it had been on hand for some time, probably more than a year. Therefore, the new sample tested in February and March 1916 represented entirely a different product embodying the improvements in manufacture which had been made in the intervening period of two or more years.

"Description of samples:

	New	Old
Pipe size, in.	5.00	5.00
Weight per foot, lb.	2.73	2.92
Thickness, in.	1.11	1.08
Apparent thickness, in. (½ of outside diameter of covering—½ of outside diameter of pipe)	1.18	1.13

"Results of test:

DATE OF TEST: FEBRUARY 23 TO MARCH 2, 1916

Temperature Difference	B.t.u. per Sq. Ft. of Pipe Surface per Deg. Temp. Dif. per Hr.		Efficiency, Per Cent	
	New	Old	New	Old
50	0.373	0.435	80.9	77.7
100	0.381	0.438	82.3	79.5
200	0.397	0.446	85.1	83.3
300	0.413	0.455	87.3	86.1
400	0.429	0.469	89.4	88.4
500	0.445	0.488	91.4	90.6

"A comparison of the above figures shows the great superiority of the new Magnesia over the old."

L. B. MCMILLAN.

New York, N. Y.

To Readers of The Journal

At the time these pages were approved for publication, there was a strike of press feeders in the printing establishments of New York City, including the one from which THE JOURNAL is issued. This will account for any delay experienced by readers in receiving the present number.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE one great lesson of the war is the bringing home of the essential need of all to be mutually helpful—that we are interdependent—as individuals, as professions, as peoples.

It is not inconsistent with Washington's admonition against entangling alliances that this nation should develop "cultural relations" with other countries.

I was about to say neighbors, because we shall soon cease to regard any place as distant. Past-President Hartness told me the other day that shortly we would use the aeroplane as a developer of new sections in much the same manner as the railroad half a century ago, with the advantage that no highway is required.

Among the specific activities to which the Secretary wishes to attract attention is the American Engineering Standards Committee.

It is proposed to organize a committee representing the Government and the professional societies on much the same lines as the British Engineering Standards Association.

This association has for over fifteen years been doing consistent work representative of the whole British nation, whereas in the United States, however meritorious individual pieces of work, notably, specifications for materials, screw threads, boiler code and safety standards, nevertheless they have been haphazard and are representative only to the degree of care with which the individual sponsor society secured representative delegates to its conferences.

The International Electrotechnical Commission, the Pan-American Scientific Congress, the International Engineering Congress and the Aircraft Stadardization Board, in all but the first of which representatives of this Society have taken a conspicuous part, have led at least the English-speaking people to the necessity for Anglo-American Standards. The Secretary is in hope that international standardization will be contemporaneous with Anglo-American, but if that is an ideal not yet capable of attainment, let us by all means proceed with Anglo-American.

In another column is the letter from Mr. Hurley respecting our Merchant Marine. President Main would like all those in the Society who are interested to advise him and give their opinions as to how the Society may respond.

Intimately bound up with Mr. Hurley's invitation is the subject of development of relations with Central and South America. We have in the Monroe Doctrine the most emphatic basis for further intercourse. On the staff of the Society at headquarters we have, too, Mr. Leon Cammen, who speaks and reads sixteen languages, and Mr. Jesse E. Vera, who has traveled extensively in South America and speaks the languages fluently. The Secretary, therefore, is not only carrying out a lifelong activity but is confident he is doing that which the Society generally wishes to be done, namely, to encourage professional organizations throughout the world to send visitors to us and to promise every assistance.

The Secretary has long established intimate friendships with officers of sister institutions abroad, and with the aid now of the Society's linguists greetings in one's own tongue can be given each visitor.

Incidentally it should be remarked that both Mr. Cammen and Mr. Vera contribute to the Engineering Survey given monthly in THE JOURNAL.

The Secretary would consider it a privilege to arrange introductions for members going abroad and, vice versa, hopes in their foreign correspondence all members will encourage prospective visitors to America to expect a warm welcome at Society headquarters.

CALVIN W. RICE,
Secretary.

Council Notes

A MEETING of the Council was held on the afternoon of Friday, September 20, 1918, at Tarrytown, New York, at the home of Past-President Worcester R. Warner. There were present: Charles T. Main, *President;* H. de B. Parsons, Wm. H. Wiley, *Treasurer;* Worcester R. Warner, D. S. Jacobus, R. H. Fernald, C. T. Plunkett, John Hunter, Arthur M. Greene, Jr., James Hartness, John Stevens, L. P. Alford, *Chairman Meetings and Program Committee;* George A. Orrok, *Chairman Publication Committee,* and by invitation, Henry Hess, *Chairman Standardization Committee;* George H. Barrus, *Chairman Power Test Committee;* F. R. Low, *Chairman Advisory Board, Power Test Committee,* L. C. Marburg, representing the *Local Sections Committee,* and Calvin W. Rice, *Secretary.* This was the first meeting of the Council at which under the amendments to the Constitution voted in effect at the Spring Meeting in June, 1918, the Chairman of the Standing Committees of Administration had a seat in the Council.

BUSINESS FROM THE PRESIDENT

Committee on Aims and Organization. The President reported that as a result of conferences and suggestions from the Local Sections Committee, he had given his hearty approval to a suggested committee, similar to that appointed by the American Society of Civil Engineers, whose purpose it would be to discuss and formulate the aims and activities of the Society in the light of modern development and present-day thought and assist in finding an effective method of cooperation with the engineering profession for carrying out these aims. Following a report by Mr. Marburg, the President was empowered to appoint a committee on Aims and Organization, to be composed of one member from each Local Section and seven members at large.

STANDING COMMITTEES OF ADMINISTRATION

Finance Committee. The recommendation of this committee as presented in the Budget of date October 1, 1918, was approved, showing a total appropriation of two hundred and thirty-five thousand five hundred and thirty-five dollars ($235,535) for the fiscal year ending September 30, 1918.

Engineering Index. The Council approved the initiation of an engineering index as part of THE JOURNAL.

Meetings and Program Committee. The appointment of C. B. Auel, H. L. Whittemore, Byron Cummings, as members of the Sub-Committee on Protection of Industrial Workers, was approved.

Prof. Wm. Kent. A committee of three to prepare a memorial to Professor Kent was approved, to be appointed by the President.

Local Sections Committee. On recommendation of this committee, it was voted to approve the exchange of courtesies with the Los Angeles Engineering and Architects' Association.

The petition from the Cleveland members for authority to form a Section of the Society in Cleveland, as the mechanical-engineering section of the Cleveland Engineering Society, was also approved.

OTHER STANDING COMMITTEES

Standardization Committee. This committee was authorized as representing The American Society of Mechanical Engineers, to take definite and active steps to assist with the formation of the American Engineering Standards Committee.

Research Committee. The chairman reported that three of the sub-committees of this committee are at present very actively at work on the subjects of lubricants, bearing metals and flow meters, and it was hoped to organize in the near future some additional special committees.

PROFESSIONAL COMMITTEES

Screw Threads and Threaded Parts. The appointment of E. M. Herr, *Chairman;* E. H. Ehrman, *Vice-Chairman;* Stanley G. Flagg, James Hartness, A. M. Houser, Frank O. Wells as a Committee on Screw Threads and Threaded Parts was approved.

The duties of this Committee will be advisory, and its members will be ex-officio members of all of the existing committees considering screw-thread standards, and such existing committees will automatically become sub-committees of the new committee.

One of the functions of the committee will also be to follow the activities of other societies and governments in the work of screw-thread standardization and avoid duplication, and an effort will be made to bring together all interests and obtain results generally acceptable.

British Engineering Standards Association. In response to an invitation of the Association, asking that the Society coöperate in standardization of Milling Cutters and Small Tools, the President was empowered to appoint a committee for this purpose.

Boiler Code Committee. Interpretations Nos. 194, 195, 196, 197, 198, 199, and reopened cases 190 and 191, of this committee were accepted. They have been published in THE JOURNAL.

The printing of the revised Boiler Code was approved subject to the approval of the entire Boiler Code Committee.

Fire Hose Couplings. A suggested standardization of Fire Hose Couplings, with an invitation of the National Board of Fire Underwriters, was approved and referred to the President, with power to appoint a Committee on Fire Hose Couplings.

SPECIAL COMMITTEES

War Activities. The Secretary presented progress reports of the following War Activities Committee: War Industries Readjustment, Machine Tool Committee and Gages Committee.

APPOINTMENTS

By the President. George A. Orrok and F. R. Low to represent the A.S.M.E. on a Joint Journal Committee, of Engineering Council.

Council of (Women's) Organizations for War Service: Mrs. Chas. Ethan Davis.

National Safety Council, St. Louis, September 16 to 20, J. P. Calderwood, M. W. Alexander, C. M. Hansen, as Honorary Vice-Presidents.

Informal Corresponding Committee on Screw Threads with British Engineering Standardization Association. E. M. Herr, *Chairman;* E. H. Ehrman, *Vice-Chairman;* R. E. Flanders, F. O. Wells, L. V. Benet, appointed as a committee, to be called British Informal Corresponding Committee—which is designed to help screw-thread standardization work in an informal way through educational methods.

By the Council. Dr. W. F. M. Goss was appointed to fill the unexpired term of two years of the late Dr. F. R. Hutton on the John Fritz Medal Board of Award.

Dr. Ira N. Hollis was appointed Chairman of the Student Branch Committee.

Adjournment was taken to meet in Indianapolis on the occasion of the Joint Section Meeting of the Mid-Western Sections on October 25. (This meeting was later postponed on account of the epidemic of Spanish influenza.)

CALVIN W. RICE,
Secretary.

Organization and Proceedings of National Screw Thread Commission

THE Commission for the Standardization of Screw Threads, authorized by Congress in accordance with Act No. 10852 of the House of Representatives, of which mention was made on page 875 of THE JOURNAL for October, was formally appointed by the Secretary of Commerce on September 21, and has been divided up into the following committees:

1 *Pitches, systems, form of thread*—F. O. Wells, Com. S. M. Robinson, E. H. Ehrman, H. T. Herr, H. W. Bearce, secretary.

2 *Tolerances, classification*—James Hartness, E. H. Ehrman, Col. E. C. Peck, H. L. Van Keuren, secretary.

3 *Nomenclature and terminology*—F. O. Wells, Com. E. J. Marquart, Major O. B. Zimmerman, Robert Lacy, secretary.

4 *Gages and methods of test*—Col. E. C. Peck, James Hartness, Com. E. J. Marquart, H. L. Van Keuren, secretary.

Seven of the members of these committees are members of the Society, namely, Messrs. Wells, Ehrman, Herr, Hartness, Peck, Zimmerman and Lacy.

As stated in the bill, the duties of the Commission are to ascertain and establish standards for screw threads, which shall be submitted to the Secretary of War, the Secretary of the Navy and the Secretary of Commerce for their approval. These standards, when approved, shall be adopted and used in the manufacturing plants under the control of the War and Navy departments and so far as practicable in all specifications for screw threads in proposals for manufactured articles, parts or materials to be used under the direction of these departments. It is also intended by the bill that the Secretary of Commerce shall promulgate such standards for use by the public and publish the same as a public document.

The first hearing for the purpose of obtaining data and views from manufacturers and users of screw-thread products was held on October 7 in the Engineering Societies Building, New York City, at which the following topics were discussed:

1 As a national standard, is there any objection to the continua-

tion of the U. S. Standard system of thread diameters and pitches for general use in practically its present shape?

2 As a national standard, is there any objection to the adoption of the S. A. E. system of diameters and pitches of fine threads?

3 As a national standard, to what extent could the A. S. M. E. system of standard machine screws be adopted?

4 There seems to be a general feeling that in standardization we should make it possible to cover several classes of work and there has been suggested a minimum of four classes of fits to provide for different grades of work ranging from reasonably wrench-tight fits to very loose fits. Would such a classification, including at least four classes, be sufficient for all grades of work encountered in the various systems of threads previously mentioned or would a classification including more than four classes be required?

5 Is there any objection to adopting the "standard hole" practice for screw threads—that is, the practice of making all the taps for any particular thread of one basic size and securing the required fit by changing the diameter of the screw on male threaded work which is to assemble with the nut cut by the basic tap?

The consensus of opinion of those present was as follows:

1. The U. S. system should be continued practically in its present form for the ordinary threaded work, to which it is well adapted.

Objections were raised to its use for diameters less than ½ in. on the ground that for small work the U. S. pitches are too coarse and the threaded work too much weakened by excessive depth of thread.

2. The S. A. E. system is satisfactory for use where finer threads are necessary, as, for example, in automobile and aeroplane work.

3. The A. S. M. E. machine-screw system should be used to supplement the U. S. system for diameters less than ¼ in., and all sizes from 14 to 30 should be discontinued in order that there may be no overlapping of the two systems. A minority thought that all A.S.M.E. sizes should be retained.

4. Classification of Fits. The general opinion was that four classes of fits would be ample to provide for all ordinary threaded work, and that very probably three classes would be sufficient, since it was felt that wrench fits, stud fits, etc., which could not be covered by general specifications should be classed as "Special," and no attempt made to include them in the regular classification.

5. Standard Hole Practice. There was a sharp difference of opinion on the question of whether the nut or the screw should be made basic, with the majority favoring the former.

A part of the objection to making the hole basic arose from a misapprehension. It was suggested that if the tap or the tapped hole were made basic it would be necessary to carry in stock several sizes of bolts in order to provide for different classes of fits. Such, however, is not the case, since in general only a single class of fit will apply to each threaded product, and only that class would be carried in stock. For example, machine screws should be made within certain tolerances, while bolts for agricultural machinery would require larger tolerances, and there would be no necessity for providing for machine-screw fits on agricultural-machinery bolts, or for "agricultural fits" on machine screws.

A second hearing was held in New York on October 21. Further hearings will be held at New York, Dayton, Detroit, Washington and other places as may be advisable, and manufacturers and users of screw-thread products are invited to attend the various hearings. Those desiring to be present should submit their intention in writing, together with a statement covering the points they wish to bring to the attention of the Commission.

After sufficient information is secured from the manufacturers and users, the Commission will decide upon the screw-thread systems to be promulgated for use as national standards and will recommend tolerances for the interchangeable manufacture of various threaded products in which the standard thread systems are used.

Ambrose Swasey's Second Gift to the Engineering Foundation

To his original gift to the United Engineering Society of $200,000 for engineering research, which made possible the establishment of the Engineering Foundation, Mr. Ambrose Swasey, Past-President Am.Soc.M.E., has added $100,000. This splendid gift, making a total of $300,000, is an expression of Mr. Swasey's appreciation of the war service already rendered by the Engineering Foundation; and of his belief in the urgent need for research in applied science in this country.

The following appreciation of Mr. Swasey's generosity has been received from the Trustees of the United Engineering Society and the Engineering Foundation:

Said Plutarch a long time ago, "To appreciate a man's work at the full it is well to know the man himself, his circumstances and the incidents of his career." He might as truly have said "gift" instead of "work."

Ambrose Swasey, engineer, collaborator with scientists, promoter of engineering research, patron of the Engineering Foundation, advancer of the good of mankind, modest gentleman and generous giver, is, happily, well known to a great many engineers, who will therefore more fully appreciate his recent additional gift, for the use of the Engineering Foundation, the purpose of which is "the furtherance of research in science and engineering, and the advancement of the profession of engineering and the good of mankind."

But full appreciation of a gift of money necessitates more than acquaintance with the giver and knowledge of the amount. Its timeliness; its inspiration; the character and continuity of its benefits, all must be comprehended. But whose imagination, though far-visioned as the great telescopes Mr. Swasey has built, can see the limits of benefit of such gifts as he has made to the Engineering Foundation, attracting—as they will—other gifts and evidences of devotion to a great cause? Every such gift lays responsibilities upon the recipients. Will American engineers grasp not merely their pecuniary value but also emulate the spirit of fraternity and desire for harmony which have accompanied them? Shall we not work together and with Ambrose Swasey to advance still further the good of mankind, thus to demonstrate an acceptance of our obligations to humanity which is a counterpart in a democracy of the *noblesse oblige* of aristocratic tradition?

Timeliness is a wonderful feature of Mr. Swasey's gifts. The first was made in the early stages of the present struggle of the nobler elements of the world against the ignoble, which has come to be "the people's war." It enables the Engineering Foundation to join with the National Academy of Sciences in responding to the President's request to bring into coöperation governmental, educational, industrial and other research agencies in the interest of the national defense and scientific and industrial research, by establishing the National Research Council. This council of scientists and engineers has already a fine record of achievement.

To his first large gift, the principal of which is still intact, Mr. Swasey has now added generously at another psychological moment. As the great conflict seems nearer an end, there lies immediately before humanity a great era of physical reconstruction, and, vastly more, an era of spiritual advancement and elevation such as has never yet been experienced. Many of the problems of human relationships, of justice and of mercy, await the genius of the engineer for their solution, quite as much as do the tasks of construction and the development of physical resources. Let us go forward with Ambrose Swasey into the fields of opportunity. Let differences be put aside and a united, mighty effort be exerted for the advancement of the engineering profession and of mankind.

ALFRED D. FLINN, *Secretary*,
United Engineering Society and Engineering Foundation.

A Society badge found in a public building in Philadelphia has been received at Society's headquarters. Further information may be obtained by addressing the Secretary's office.

ANNUAL MEETING PROGRAM

New York, December 3 to 6, 1918

(Tentative; Other Papers to be Announced Later)

Tuesday Evening, December 3

Report of Tellers of Election and Introduction of the President-Elect

Presidential Address, followed by Reception

Wednesday Morning, December 4

Business Meeting: Amendments to Constitution; Reports of Standing Committees of Administration and Standing Committees; Reports of Special Committees, including Standardization of Flanges and Pipe Fittings

Preliminary Report of the Committee on Aims and Organization

Wednesday Noon

Luncheon and Address by Dr. George W. Kirchwey, formerly Dean of Columbia Law School, on A Message from the Legal Profession

Wednesday Afternoon (Simultaneous Sessions)

MACHINE-SHOP SESSION

MEASUREMENT OF THREAD GAGES, H. L. VanKeuren

STANDARDS FOR LARGE TAPER SHANKS AND SOCKETS, Luther D. Burlingame

It is also expected that reports will be presented on the work of the British Engineering Standards Association.

In connection with this session, the Bureau of Standards has arranged for an exhibit of the measuring apparatus and methods of the Bureau in testing screw-thread gages.

JOINT SESSION ON REFRIGERATION

The American Society of Refrigerating Engineers will join with this Society in a session on Refrigeration, with the following subjects:

REFRIGERATING PLANT EFFICIENCY, Victor J. Azbe

Topical Discussion on Fuel Economy in Refrigerating Plants

GENERAL SESSION

WEIGHTS AND MEASURES OF LATIN AMERICA, Frederick A. Halsey

Papers on Management, with particular reference to the U. S. Shipping Board

Wednesday Evening

Lecture on The Achievements of Naval Engineering in the War by William L. Catheart, Lieutenant-Commander, U. S. N. R. F.

Thursday Morning, December 5

Keynote Session on the general subject of Engineering of Man Power

Papers and addresses will be contributed to this session on: Organization; Standardization and Administration of Wages; Non-Financial Incentives; Incentive of Control in Industry; Employment of Labor; Dilution of Labor; Intensive Training; Human Relations in Industry

Thursday Afternoon (Simultaneous Sessions)

KEYNOTE SESSION

Continuation of morning session on the general subject of Engineering of Man Power

TEXTILE SESSION

INDUSTRIAL POWER PROBLEMS, W. F. Uhl

PROPERTIES OF AIRPLANE FABRICS, E. Dean Walen

DAYLIGHT VS. SUNLIGHT IN SAWTOOTH ROOF CONSTRUCTION, W. S. Brown

FACTORY STAIRS AND STAIRWAYS, G. L. H. Arnold

GAS-POWER SESSION

THE COOLING LOSSES IN COMBUSTION ENGINES AS AFFECTING DESIGN, C. A. Norman

DISCUSSION OF CERTAIN PROBLEMS IN REGARD TO MARINE DIESEL OIL ENGINES, J. W. Anderson

This session will be largely devoted to a discussion of the subject of oil engines

Thursday Evening

Motion pictures relating to the technical side of war; dancing will follow

Friday Morning, December 6 (Simultaneous Sessions)

POWER-PLANT SESSION

THE CONSERVATION OF HEAT LOSSES FROM PIPES AND BOILERS, Glen D. Bagley

CHEMICAL AND PHYSICAL CONTROL OF BOILER OPERATION AND APPLICATION OF SIMPLE FORMULA FOR ESTIMATING THE HEAT-LOSS ITEMS, E. A. Uehling

GENERAL SESSION

THE RELATIVE CORROSION OF ALLOYS, R. B. Fehr

THE RELATIVE MERITS OF CAST-IRON, WROUGHT-IRON AND STEEL PIPE FOR HOUSE-DRAINAGE PURPOSES, Wm. P. Gerhard.

THE DESIGN AND MAINTENANCE IN OPERATION OF HYDRAULIC VALVES AND FITTINGS FOR USE WITH PRESSURES FROM 1000-8000 LB. PER SQ. IN., Wm. W. Gaylord

MECHANICAL FEATURES OF THE VERTICAL-LIFT BRIDGE, Horatio P. Van Cleve

INDIANAPOLIS MEETING POSTPONED

ALTHOUGH the ban on public meetings was about to be removed in Indianapolis at the time the Council meeting and the meeting of the Mid-Western Sections was scheduled to be held in that city, October 25 and 26, it was nevertheless considered advisable to postpone the event to a later date.

The meeting is tentatively scheduled for November 15 and 16 and members will receive individual notice. If this arrangement can be made, the Indianapolis committee will endeavor to carry through the program as arranged for the original meeting. The program of the meeting was as follows:

First Day

9:30 a. m. Registration at Claypool Hotel.

11:30 a. m. Meeting of the Committee on Local Sections and members of the Executive Committees of the Mid-Western sections.

12:30 p. m. Informal luncheon at the Claypool. The Mayor of Indianapolis will welcome the visitors and President Main will respond.

2:00 p. m. Symposium on Fuel Conservation:

Session opened by Professor Charles Russ Richards, Dean of the College of Engineering and Director of the Engineering Experiment Station of the University of Illinois.

An explanation of the Regulations of the Fuel Administration, by Dr. P. B. Noyes, Director of Publicity and Information, U. S. Fuel Administration.

What the Fuel Administration Expects of the Engineer, by David Moffat Myers, Advisory Engineer, U. S. Fuel Administration.

Fuel Economy on the Railroads, by Major E. C. Schmidt, of the Railway Fuel Economy Division.

Discussion, in which the Administrative Engineers of the Fuel Administration and members of the Society will participate.

Storage of Coal, by Prof. H. H. Stoek, University of Illinois.

6:30 p. m. Informal dinner, at which nominee for President M. E. Cooley, is expected to speak, followed by war pictures.

Second Day

9:00 a. m. Symposium on Research.

Opening addresses by Profs. Arthur M. Greene, and Walter Rautenstrauch, members of the Society's Committee on Research.

Address by Mr. C. E. Skinner, Engineer, Research Division, Westinghouse Electric & Manufacturing Co. on Organized Research in Connection with the Industries.

Address by Dr. W. J. Lester, Vice-Chairman of the Engineering Division, National Research Council.

Paper to be submitted by Dr. H. M. Howe, Chairman of Engineering Division of the National Research Council.

Discussion by members of the Society.

12:30 p. m. Informal luncheon at place arranged by the Local Committee.

2:30 p. m. Visit to Nordyke & Marmon's plant to witness the manufacture of the Liberty Motor.

AMONG THE SECTIONS

THE Committee on Local Sections gives the folliwing information to the Local Executive Committees on the subject of formulating local constitutions and by-laws in conformity with the national by-laws governing Local Sections which have been in successful operation since October 1917.

These national by-laws were the result of two years' work on the part of the major committee, and they were framed with the object of covering all the variety of conditions existing in the several centers, and at the same time affording opportunity to the individual Sections to carry on activities of local interest.

To date a number of the Sections have given attention to this matter of constitution and by-laws, and for the benefit of the other committees who might like to institute this piece of work the Committee on Local Sections drafted a blank form of constitution which has been sent to all the Sections through the medium of the record books of their chairmen and secretaries.

It is interesting to review some of the documents which govern the Local Sections' activities. It should be noted that in some cases the coöperation is so close that the name of our Section has been written in the local society constitution.

The By-Laws of the Affiliated Technical Societies of Atlanta antedate our national by-laws, having been adopted in 1913. The fundamentals of this organization are that the local sections of the national engineering societies and the Chemical Society and the Engineering Association of the South have equal rights and privileges. The by-laws are brief, governing the executive committee and the order of business at the meetings. All the members of the participating organizations are included as members of the Affiliated Association.

The document of St. Louis exemplifies very forcibly the unification and coöperation of all the Societies in that important center. The Association is managed by a Council on which are represented the Engineers' Club and each of the affiliated societies. This Council has jurisdiction over all matters of joint interest in so far as its decisions shall not conflict with the rules of the individual societies. The constitution provides for the joint action on all local public affairs presented for consideration to any one or more of the societies. It also provides for action on national public affairs, and the Council is empowered to refer questions to the consideration of one or more national engineering bodies through their affiliated societies. In all the other articles of the constitution which cover meetings, dues and services the idea of joint action on all matters predominates.

The constitution of the Birmingham Section was adopted in March 1916 and provides inclusively for the organization of the Birmingham Section. The document states that the objects of the local Section shall be the professional improvement of the members of the A.S.M.E. residing in and near Birmingham; the encouragement of social intercourse among them, the advancement of engineering in its several branches, the advancement of the engineering profession in the opinion of the general public, and the influencing in a dignified manner of the solution of public questions involving engineering and scientific consideration. The constitution provides for membership, for officers and their duties, for the annual and monthly meetings, and for amendments.

The Indianapolis Section, which is only two years old, has already a very complete constitution and by-laws, very similar to that of Birmingham in the statement of objects of the Section, in the membership, the officers, and meetings. The by-laws provide for the order of business at the meetings, for the nomination of officers, and for the parliamentary standards.

The New York Section operates under a constitution only, which was adopted on May 1, 1918. The constitution is brief, and its articles cover the name of the section, membership, officers, nominations and miscellaneous.

Philadelphia has been considering a constitution this summer, and a draft of the proposed constitution was presented at its September meeting. The significant feature of the Philadelphia constitution is the provision for the Executive, Papers, Meetings, Public Relations, Research, Nominating, Auditing and Membership Committees. The organization in Philadelphia, therefore, is more nearly comparable with the organization of the parent Society, and the suggestion this document develops is that it may be desirable to encourage the local executive committees to form sub-committees parallel with the committees of the major organization with a view to increasing the inter-committee relations of the parent society, and thus contribute very materially to the strength of the organization.

Minnesota has also drafted a constitution which is now under consideration for adoption. The document itself states that it has been drawn up " to cover in detail the peculiar organization which has been developed for the Minnesota Section and its particular purpose is to form a guide for future work so that activities can be carried along with uniformity." The article on membership provides for local members who are not members of the A.S.M.E. and includes members of the Student Branch in the State of Minnesota as full members of the Section. In the article entitled Activities the object of the Section is stated to be for the holding of meetings for the presentation and discussion of papers relating to engineering, and to the allied arts and sciences, and also for holding meetings of social intercourse, and making trips to plants engaged in engineering enterprises.

In all the constitutions formulated so far, there is a significant element of individuality. The provision of the national by-laws is that local sections may frame their own rules, but they should conform as far as possible with the spirit of the national rules. The various interpretations of these sentiments by the local committees are interesting, and it is to be hoped that soon each one of our twenty-two sections will adopt a form of by-laws which will most nearly meet its local needs.

Section Meetings

BIRMINGHAM

October 24. The program for this event of the local society, held at the Birmingham Civil Association's rooms, was under the auspices of the Birmingham Section. E. H. Rosseau, chief engineer of the Birmingham Machine & Foundry Co., delivered an interesting and timely paper, illustrated with balopticon views, on The Manufacture of Raw Sugar. The meeting was followed by a buffet lunch.

JAMES W. MOORE,
Secretary.

BOSTON

October 17. A meeting of the Section, together with the Boston members of the A.I.E.E., A.S.C.E., Waterworks Association, Worcester Section, Providence Engineering Society, and the Manufacturers' Association of Eastern Massachusetts, was held in Lorrimer Hall. Magnus W. Alexander, Mem.Am.Soc.M.E., read a paper on The Elements of the Labor Problem.

ELMER SMITH,
Secretary.

CHICAGO

October 28. A joint meeting with the Chicago Section of the A.I.E.E. was held, the subject being Illumination. A paper was read by Professor Clewell.

ARTHUR L. RICE,
Secretary.

CLEVELAND

October 4. The newly established Section organized with the following officers: E. S. Carman, *Chairman;* J. H. Stratton, vice-chairman; J. H. Herron, secretary, and Willard Brown, treasurer.

J. H. HERRON,
Secretary.

INDIANAPOLIS

October 25-26. The joint meeting of the Council with the mid-western sections has been postponed, due to the influenza epidemic.

CHARLES BROSMAN,
Secretary.

LOS ANGELES

The Los Angeles Section united with the Technical Societies of Los Angeles in an official effort to assist the fourth Liberty Loan. This definite act on the part of the profession should be the forerunner of future nation-wide organization for civic welfare.

T. J. ROYER,
Secretary

CONNECTICUT
(New Haven Branch)

October 9. This meeting was postponed due to the influenza epidemic.

E. H. LOCKWOOD,
Secretary.

MINNESOTA

October 7. A meeting was held at the rooms of the St. Paul Association. Dinner was served at 6.30 and there were 40 members and guests present. F. W. Speer, Jr., Chief Chemist of the H. Koppers Co., Pittsburgh, read a paper on By-Product Coking, Particularly in Its Relation to the Steel and Iron Industry. Mr. Speer gave a short history of the development of the coke industry. Then by means of a series of lantern slides he described a complete by-product coke plant, and told in a very concise manner how the coke is produced and the by-products conserved. The lecture was followed by a lively discussion.

Among the guests were Capt. L. P. Riggins, Lieut. B. A. Meixner, and Lieut. J. J. Hanson, of the Ordnance Department, U. S. A.

RAY MAYHEW,
Secretary.

NEW ORLEANS

October 14. The Section held its monthly meeting in conjunction with the Louisiana Engineering Society.

E. W. CARR, JR.,
Secretary.

NEW YORK

September 28. At the invitation of Mr. John Hunter, a member of the Council and naval constructor of the Standard Shipbuilding Corporation, members of the Section were guests of the company on the occasion of a double launching at the Shooter's Island yard, Staten Island, of two 7500-ton vessels, the steamships Monmouth and Dallas. Probably 750 men and women participated and the company provided two commodious excursion steamboats to carry the party between the Battery and the shipyard, and tendered an unexpected collation after the launching.

H. D. EGBERT,
Secretary.

PHILADELPHIA

September 24. The initial meeting of the 1918-1919 season was held at the Engineers' Club. The address of the evening was given by W. H. Blood, Jr., of the American International Shipbuilding Corporation, on The Making of Hog Island, the Greatest Shipyard in the World. This address was illustrated with many lantern slides, and film showing the launching of the first vessel from that yard.

At this meeting the proposed by-laws for the government of the Section, mentioned above, were submitted.

October 22. This meeting was postponed, due to the influenza epidemic.

J. P. MUDD,
Secretary.

ST. LOUIS

September 27. The first of the fall meetings was held in the Daniel Boone room at the Statler Hotel, preceded by a dinner. J. A. Whitlow, Administrative Engineer of the United States Fuel

October 23. This meeting was postponed, due to the influenza epidemic.

J. P. MORRISON,
Secretary.

SAN FRANCISCO

September 26. As reported in the October JOURNAL, a joint meeting of the local section of the A.S.C.E., A.S.M.E., A.I.M.E., A.I.E.E. and A.C.S. was held in the Engineers' Club, under the auspices of the local section of this Society.

The subject was Fuel Conservation, and consisted of a Symposium by the following speakers:

Albert E. Schwabacher, U. S. Fuel Administrator for California, Fuel Conservation; A. H. Markwart, Civil Engineer, Production of Energy; D. M. Folsom, U. S. Fuel Administration, Oil Division, Future Requirements of Oil; John A. Britton, V. P. and General Manager, Pacific Gas & Electric Co., The Use of Gas as a Conservation Measure; H. G. Butler, Power Administrator, Electric Consolidatioins and Their Relation to Fuel Conservation; P. M. Downing, Chief Engineer Electric Department, Pacific Gas & Electric Co., Sources of Energy Supply; Harry S. Markey, Mem. Am. Soc. M. E., District Steam Heating as Related to Fuel Conservation; Major George F. Sever, War Industries; W. J. Davis, Pacific Coast Engineer, General Electric Co., Railroad Electrification as a Fuel Conservation Measure; and Professor Edmund O'Neill, Mem.A.C.S., The Chemical Side of Fuel Conservation.

The reading of these papers was followed by a general discussion.

GEORGE L. HURST,
Secretary.

Student Branches

The new military program as outlined by Secretary Baker calling for an increase of the Army by more than two million men by July 1, 1919, has vitally affected the technical colleges throughout the country. Since the students are not in any sense in a deferred or favored class, and will practically all be assigned to active service within the next year, schools and colleges obviously must undergo fundamental changes in school practice in order to render effective service.

In about 550 institutions Students Army Training Corps have been established, and these institutions will therefore cease to function as purely academic universities and will become a part of the Nation's war machine. The object of establishing these units is to utilize effectively the plant, equipment and organization of the colleges for selecting and training officer-candidates and technical experts for service in the existing emergency.

The Corps is divided into two sections, the Collegiate (or "A") Section and the Vocational (or "B") Section. The units of the "B" Section were formerly known as National Army Training Detachments. They aim to train soldiers for service as trade specialists in the Army.

The "A," or Collegiate Section, inaugurated October 1, is open to registrants who are members of some authorized college, university or professional school. Students of authorized institutions may join the Students Army Training Corps by voluntary induction into the service. They thus become members of the Army on active duty, receiving pay and subsistence, subject to military orders, and living in barracks under military discipline in exactly the same manner as any other soldier.

The housing, subsistence and instruction of soldiers in both branches of the Students Army Training Corps is provided by educational institutions under contractt with the Government.

The members of the Students Army Training Corps are voluntarily inducted into the service, and are ordinarily allowed to choose the branch of the service for which they wish to be prepared. This freedom of choice, however, is not absolute. It depends upon the individual's qualifications and upon the needs of the service at any particular time. The status of a member of the Students Army Training Corps is that of a private.

Members of the Students Army Training Corps, having already been inducted into the service, will not come under the operation of the Selective Service Law. It is expected that the members of Collegiate Sections will be transferred from institutions every three months in age groups, the twenty-year-old men going first, the nineteen-year-old men going next, and the eighteen-year-old men last, roughly corresponding to the period at which men of these ages will be called under the Selective Service Law. As these groups leave the colleges their places will be taken by new contingents obtained by individual induction, or, if necessary, in depot brigades. Students of such subjects as engineering, chemistry and medicine may be required to finish their courses where the needs of the service make this desirable.

Members of Vocational Sections will ordinarily remain at the institution for two months and will then be assigned to various branches of the service in which technicians are needed.

In addition to 11 hours per week of military training the course of study in the Collegiate Section of the Students Army Training Corps will consist of the ordinary college or technical courses grouped and modified in such ways as are necessary to meet the needs of the War Department.

Members of Vocational Sections will pursue such subjects as auto-driving, auto-repair, bench woodwork, sheet-metal work and electrical work, etc., in addition to 13½ hours per week of military training.

Members of both sections will attend courses on the Issues of the War.

At certain specified institutions, a limited number of registrants may, upon indicating their preference, be inducted into the Navy or the Marine Corps. Such men will wear naval uniforms, and pay their own expenses individually from an allowance made to them by the Navy Department. The Naval and Marine Sections will attend all drills and exercises of the Students Army Training Corps.

In this new development the Committee on Student Branches hopes there will be an opportunity for furthering the work of the Student Branch Organization. If the very full curricula preclude the holding of meetings of Student Branches it is hoped a skeleton organization with regularly appointed officers will be formed in order that the privileges of Student Branch membership may be obtained.

Society Donates Rooms to War Department

As a policy, the Society has no "slacker" rooms at its headquarters. The Committee on Education and Special Training, directing the Students' Army Training Corps, numbering 150,000 men in the principal colleges of America, are now the Society's guests and occupy the Members' Reception Room and the Council Room as headquarters for the Second District of the Committee.

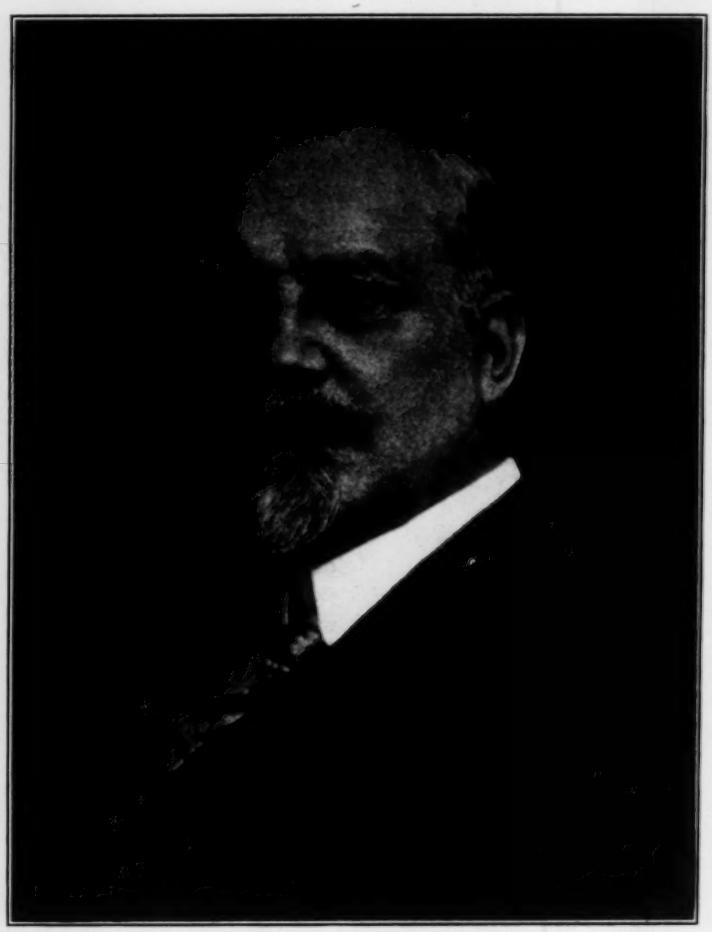
Recently also the Congressional Commission on Standardization of Screw Threads has met in the Society's rooms. The Council considers it an honor to have headquarters freely used by the Government or by committees of other societies—in fact, *Service to the Utmost* is the Society's motto.

NECROLOGY

WILLIAM KENT

In the death of William Kent on September 18, announcement of which was made in the last number of THE JOURNAL, the Society has lost a member who will be sadly missed by a very large number who have regularly met him at the Society's meetings, or have come in contact with him in a professional way.

Mr. Kent was an organization member of the Society, and Vice-President from 1888 to 1890. He was preëminently versatile, an original thinker, a ready speaker, an author and frequent contributor of papers and technical articles, and an engineer whose services were much in demand in a consulting capacity or as an expert in patent cases. He was a regular attendant at the Annual and Spring Meetings, and probably contributed more largely to the discussion of the various papers than any other member, besides being the author of no less than 12 papers, a number of which were noteworthy contributions to engineering knowledge.



WILLIAM KENT

As the author of the Mechanical Engineers' Pocket-Book his name became known among engineers the world over, and through this medium he rendered an almost incalculable service to the engineering profession. For many years Mr. Kent had followed the practice of clipping and filing data on engineering subjects, and this material was made the basis of the first edition of his book in 1895. At that time practically the only American engineering pocketbooks were Trautwine, in the civil engineering field, and Haswell, largely mechanical, but dealing with engineering of an earlier day when rule-of-thumb rather than research was the main reliance. In Kent's book the practice was followed of summarizing the data and giving the sources of authority, so that any of the subjects could be investigated further.

William Kent was born in Philadelphia on March 5, 1851. He was educated in the schools of that city, and later, while employed with the Jersey City Gas Company, he attended the night classes of Cooper Union for a period of five years. He then became connected with the blast furnace of Cooper, Hewitt and Company, Ringwood, N. J., where he remained until 1874. Becoming convinced of the necessity of further education, he entered Stevens Institute of Technology, first as a special student in chemistry, and later, at the instance of the late Dr. Robert H. Thurston, enrolled himself in the senior year class, graduating in 1876 with the degree of mechanical engineer. During his senior year he engaged upon investigations for Dr. Thurston upon the alloys of copper. During 1884-1885 he was president of the Alumni Association of the Institute.

From 1877 to 1879 he was editor of the *American Manufacturer and Iron World* of Pittsburgh, resigning to become superintendent of the open-hearth plant of the Schoenberger Steel Company. Leaving the steel business he took charge of the Babcock and Wilcox Company's Pittsburgh office, later being transferred to the New York office. While with this company he made numerous inventions on boilers, furnaces and boiler accessories. In 1887 he became general manager of the Spring Torsion Balance Scale Company and developed the methods and machinery for building this highly sensitive scale.

In 1891 Mr. Kent began the practice of consulting engineer and in 1895 became associate editor of *Engineering News*, a connection continued until 1903, at which time he was offered and accepted the position of dean of mechanical engineering in the L. C. Smith College of Applied Science in Syracuse University. He remained at Syracuse until 1908, when he became general manager of the Sandusky Foundry and Machine Company, Sandusky, Ohio. In 1910 he resumed his consulting engineering practice and at the same time became contributing editor to *Industrial Engineering*.

Besides his Mechanical Engineers' Pocket-Book, Mr. Kent was also the author of Steam Boiler Economy, Investigating an Industry, Bookkeeping and Cost Accounting for Factories, as well as papers presented before the numerous technical societies of which he was a member, and articles contributed to the technical press. He was a lecturer at many colleges and technical schools, including Yale, Cornell, University of Illinois, West Virginia University, Stevens Institute, Brooklyn, Franklin and Worcester Polytechnic institutes, and many others.

Mr. Kent was regarded as an authority on steam-boiler practice and on shop management. He was an earnest advocate of the principles of scientific management as enunciated by Frederick W. Taylor and was one of the charter members of the Taylor Society. He was also an inventor and designed the wing-wall furnace to secure complete combustion where there was not room for the Dutch-oven furnace, and developed a gas producer similar to the Dawson, but entirely independently of the latter. Singularly, his American patents and the English Dawson patents were issued on the same day. Many other inventions and devices are to his credit.

He also was engaged upon numerous investigations, notably work for the Babcock and Wilcox Company on high-volatile coals, for the New York Edison Company on smoke abatement, and in New Jersey with regard to certain water rights. Latterly he devoted much of his time to patent cases as an expert.

Besides his membership in this Society, he was a member of the American Society of Heating and Ventilating Engineers, of which he was president in 1905; American Institute of Mining Engineers; Society for the Promotion of Engineering Education; American Association for the Advancement of Science, and a number of others. He was a member of the Power Test Committee of the A.S.M.E. In 1907 he received the degree of Doctor of Engineering from Syracuse University. He is survived by his wife, one daughter and two sons, Robert Thurston Kent, and Lieut. Edward R. Kent, U. S. A., both engineers.

A. C. BEESON

A. C. Beeson was born in Salem, Ohio, on February 26, 1845. He was educated in the "village schoolhouse" there, obtaining in

addition a fair knowledge of mechanics in his father's machine shop. His first employment was at Pithole, Pa., in 1865, where he engaged successively in pumping and drilling wells. It was not until 1868 that the opportunity, which proved to lead to his life's work, came to him when he was engaged as gauger by the Titusville Pipe Co. and assigned to duty in the Pleasantville district. In June 1870 he entered the service of Vandergrift & Forman and constructed a pipe line from White Oak Station, now Trunkeyville, to Fagundas. The rapid extension of the oil fields in the early seventies was accompanied by unusual activity in pipe-line construction and Mr. Beeson was called on to construct pipe lines in districts of widely separated localities.

When Vandergrift & Forman organized the Fairview Pipe Line, the piping system was vastly extended under Mr. Beeson's direct supervision. He remained with this company and its successor, the United Pipe Lines, until 1885, when he purchased and took charge of a natural-gas plant in the lower-country oil towns. In 1889 he disposed of his gas interests and returned to the pipe-line industry as superintendent of the Western & Atlantic Pipe Line with headquarters in Pittsburgh. He was appointed superintendent of the Indiana Pipe Line upon its organization in 1899 and later vice-president, which position he held at the time he was taken ill. He died on September 10, 1918. He became an associate-member of the Society in 1914.

W. A. BLONCK

W. A. Blonck was born on April 30, 1872, in Wriezen, Germany. His early education he obtained in the Real Gymnasium of Wriezen, later receiving the degrees of M. E. and E. E. from Mittweida, Saxony, in 1893.

His first position was with the Royal Saxon Railways, Dresden, on construction work of transmission lines in connection with a three-phase power station for Dresden depots. In 1894 he was employed by Körting Brothers, Hanover, Germany, to design electric machinery and apparatus, and the following year he was connected with Siemens and Halske, Magdeburg, Germany, on the estimates and supervision of construction of isolated factory plants. From 1896 to 1901 he was with Ganz & Co., Budapest, Austria-Hungary, working on estimates and supervision of construction of steam and hydraulic municipal plants in Bulgaria, Hungary and Austria. In 1901 he came to the United States and for about a year was with the Chicago Edison Co., Chicago, Ill., on the preliminary work of the design of the large Fisk Street power plant. From 1902 to 1904 he was associated with the Arnold Electric Power Station Co., Chicago, when he became electrical engineer in charge of construction and operation for the Chicago and Milwaukee Electric Railroad Co. The years from 1905 to 1912 he had consulting offices in Chicago where he specialized on reports, design and construction of railway, light and industrial plants. In 1912 he became president of the W. A. Blonck Co., Inc., Chicago, which position he occupied at the time of his death, January 14, 1918.

Mr. Blonck was particularly interested in the development of the boiler efficiency meter and upon his submitting his investigations and tests in that connection to The Franklin Institute, received a Certificate of Merit for establishing graphically the zero method of best boiler efficiency. He also conducted special investigations of boiler-furnace operation and definite methods of doing away with guesswork in the fire room. He became a member of the Society in 1916.

ROBERT M. DIXON

ROBERT MUNN DIXON

A Tribute by The Secretary

Robert M. Dixon, for 34 years a member of The American Society of Mechanical Engineers and the chairman of its Finance Committee, died suddenly at his home at East Orange, N. J., on October 17, 1918. His death came as a great shock to his many friends, as he had been at business regularly and apparently had been in his accustomed health and had attended to his affairs with his usual energy and attention to their many details up to the very date of his passing away.

It has been the writer's privilege, as Secretary of this Society, to be intimately associated with Mr. Dixon in relation to its numerous activities where his sound judgment and constructive suggestions were not only helpful, but of the greatest intrinsic value.

His interest in the Society as an organization was deep-seated and very real, and it would be impossible to give an adequate appreciation of the service which he rendered. He served on the Finance Committee for ten years, for over eight years as chairman. During this period, the income of the Society was nearly doubled; the indebtedness occasioned by the acceptance of the Carnegie gift of the Engineering Building, nearly $100,000, was paid off and the cash surplus of the Society brought up to an excess of $100,000.

It was a part of Mr. Dixon's financial policy and direction that in so responsible and important a work as the Society is undertaking, it should accumulate as an essential part of that responsibility a sufficient cash surplus to provide for unforeseen and unprovided-for expenses of administration (as publications, meetings, etc.) so that their future would be assured beyond any possible doubt.

The Society is one-fourth owner and administrator of real estate worth $2,500,000, besides the publisher of its annual volume of TRANSACTIONS and the monthly JOURNAL, costing annually $100,000.

In this capacity as chairman of the Finance Committee, Mr. Dixon was a most faithful attendant upon the meetings of the Council, invariably contributing the broadest concept of the Society's duties and recognizing that the technical and even the ethical success of the Society is to a large degree dependent upon a sound financial administration.

The bringing up, therefore, of the Society from a position of lesser importance relatively, both in its membership and in its financial standing, to that of the sister professional societies, to that of one of the leading professional societies of the United States, is a work deserving of the highest praise, and to its success Mr. Dixon contributed conspicuously.

Robert M. Dixon was born at East Orange, N. J., September 19, 1860, in the house where he lived at the time of his death. He was educated in the public schools and graduated from Stevens Institute of Technology in the class of 1881, with the degree of M. E. Subsequently, he took a great deal of interest in the affairs of the Institute, was elected president of the Alumni Association for the period 1898-1899, and was an alumni trustee from 1890 to 1893.

His engineering work began with the Delaware Bridge Company, of Trenton, N. J., where he was employed for two years until March 1883, when he was made assistant engineer of the Pintsch Lighting Company, which was merged with the Safety Car Heating and Lighting Company in 1887, with Mr. Dixon as chief engineer. He was elected vice-president of the Safety Car Heating and Lighting Company, January 15, 1902, and was made president of the company in May 1907, which office he was holding at the time of his death.

Mr. Dixon spent the greater part of his life in the field of railway-car heating and lighting, and was identified with the early application of steam from the locomotive for heating railway passenger cars and with the development of gas and electricity for lighting railway cars. He was also active in the field of harbor and coast lighting.

He was elected on the Board of Trustees of the United Engineering Society, as representative of this Society, December 1917, and was also member of the Finance Committee of the United Engineering Society.

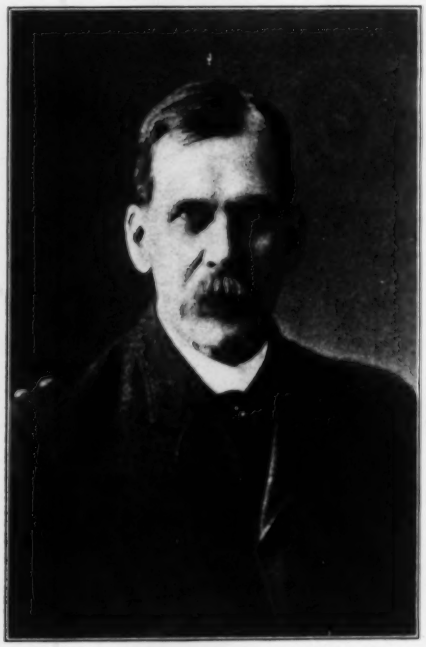
Mr. Dixon gave a great deal of attention to railroad matters and was active as an executive officer of the New York Railroad Club from its earliest days as a club of railroad men. He served as treasurer of the club from 1903 to the time of his death. He was formerly chairman of the finance committee of the club, and was a member of its executive committee for 35 years.

WILLIAM J. KEEP

William J. Keep, for many years consulting engineer for the Michigan Stove Co., Detroit, and one of the best-known writers of the country on foundry topics, died on September 30 following an accident, when he was knocked to the pavement by a street car and sustained fatal injuries.

Mr. Keep was born in June, 1842, in Oberlin, Ohio. He attended Oberlin College for his freshman and sophomore years and was graduated from Union College, Schenectady, N. Y., in 1865, with the degree of civil engineer. He served an apprenticeship with the Globe Iron Works, Cleveland, and obtained his shop experience with Fuller, Warren & Co., Troy, N. Y. From 1865 to 1868 he was employed by Hubbell & Brothers, Buffalo stove manufacturers, when he became associated again with Fuller, Warren & Co. and was with them for about eight years. During the years of 1872 to 1877 he delivered a course of lectures to the senior class of Rensselaer Polytechnic Institute. From 1875 to 1884 he manufactured stoves on his own account in the city of Troy.

In 1902 his treatise on Cast Iron was published, which is the best known of his writings. In 1885 Mr. Keep brought out some results of his studies of the relation between the shrinkage of



WILLIAM J. KEEP

cast iron and the composition of a foundry mixture. Later he devised a method and apparatus known as "Keep's Test" which he later named "Mechanical Analysis," for the determination of shrinkage in cast iron, and in this way to regulate the cupola mixture. For this purpose he used a ½-in. test bar. He elaborated his method of testing after making many thousands of tests in the investigation of the relation between the chemical analysis of cast iron and its physical properties, and the results were embodied in his writings.

Mr. Keep became a member of our Society in 1893 and from 1903 to 1905 was vice-president. He was also a member of the American Institute of Mining Engineers, the (British) Iron and Steel Institute, the International Association for Testing Materials, the American Foundrymen's Association, the American Association for the Advancement of Science, the Detroit Engineering Society (Past-President), honorary member of the Rensselaer Society of Engineers, and The Franklin Institute.

ROLL OF HONOR

DIED IN THE SERVICE

Walter Antosch, Chief Machinist, U. S. S. Westbridge, U. S. Navy.

Arthur H. Burges, Sergeant, 23d Engineers, U. S. Army, American Expeditionary Forces, France.

William R. King, Major, Ordnance Department, U. S. Army, Aberdeen Proving Ground, Md.

The following list of those in the Service is made up of the names of members of the Society sent in during the month of October. The number of stars in the service flag is now over 1100.

ABBOTT, EDWARD R., Captain, Chemical Warfare Service, U. S. Army.

ARMSTRONG, WALTER J., Captain, Ordnance Department, U. S. Army.

BARNABY, RALPH S., Ensign, U. S. Navy, Inspection Division of Naval Flying Corps.

BENSON, CARL N., Machinist, Second Class, U. S. Navy, assigned to U. S. S. *Montclair*.

BUCKINGHAM, J. E. E., First Lieutenant, Engineers Corps, U. S. Army, assigned to Co. 7, Engineer Officers' Training School, Camp Humphreys, Va.

BUNKER, W. D., Captain, Engineers' Corps, U. S. Army.

CHANCE, T. M., Major, Chemical Warfare Section, U. S. Army, assigned to Edgewood Arsenal, Md.

CLARK, ALBERT J., Main Ship Cr 21, Naval Aviation Detachment, Cambridge, Mass.

COLDWELL, C. B., Second Lieutenant, Ordnance Department, U. S. Army.

COTTMAN, LEWIS W., Major, Gas Defense Division Chemical Warfare Service, U. S. Army.

DAGAVARIAN, NISHAN A., Chief Machinist's Mate, U. S. Steam Engineering School, U. S. Navy; assigned to Stevens Institute, Hoboken, N. J.

DANFORTH, T. DWIGHT, Second Lieutenant, Field Artillery, U. S. Army.

DEMOREST, WILLIAM J., Captain, Ordnance Department, U. S. Army.

EVERETT, CHESTER M., Captain, Sanitary Corps, U. S. Army, Fort Oglethorpe, Ga.

FELL, HUGH P., First Lieutenant, Company D, Second Battalion, 37th Engineers, American Expeditionary Forces, France.

FOGLER, B. B., Major, Mechanical Research and Development Section, Chemical Warfare Service, U. S. Army, assigned to Washington, D. C.

FULLER, RAY W., Major, Ordnance Department, U. S. Army.

GEDDIS, ROBERT H., Corporal, 16th Company, 152d Depot Brigade, Camp Upton, N. Y.

GOALWIN, HARRY A., Enlisted Medical Corps, U. S. Army.

HANSON, J. J., First Lieutenant, Inspection Division, Ordnance Department, U. S. Army, assigned to Minneapolis Steel & Machinery Co., Minneapolis, Minn.

HILL, GEORGE F., Captain, Ordnance Department, Chemical Warfare Section, U. S. Army.

JACKSON, F. RAYMOND, Chief Machinist's Mate, U. S. Navy, Candidate Steam Engineers' School for Officers, Stevens Institute of Technology, Hoboken, N. J.

JUDSON, CYRUS F., Captain, Ordnance Department U. S. Army, assigned to Camp Logan, Houston, Tex.

KARMAZIN, JOHN, Captain, Military Intelligence Division, General Staff, U. S. Army.

KIEFER, PAUL J., Ensign, U. S. Navy, U. S. Navy Steam Engineering School, Hoboken, N. J.

LACY, ROBERT, First Lieutenant, Company I, Engineer Officers' Training School, Camp Humphreys, Va.

LEH, C. F., Candidate, Engineer Officers' Training Camp, Camp Humphreys, Va.

LINCOLN, C. W., Private, Co. E, 3d Regiment Air Service Mechanics' School, St. Paul, Minn.

LOCKETT, KENNETH, Captain, Engineers, U. S. Army.

LUCKE, CHARLES E., Lieutenant-Commander, U. S. Navy.

LUNDGREN, EDWIN, Coast Artillery, U. S. Army, assigned to Fort Monroe, Va.

LUNDQUIST, JOSEPH M., Private, U. S. Infantry, assigned to Camp McArthur, Tex.

MCARDELL, WESLEY, Private, Ordnance Student Officer Training School, Erie Proving Grounds, Port Clinton, O.

MCINTOSH, SAMUEL F., Captain, Ordnance Department, U. S. Army.

MCMURTRY, ALDEN L., Major, War Plans Division, General Staff, U. S. Army.

MITCHELL, GEORGE L., Private, Intelligence Section, American Expeditionary Forces, France.

MUIR, LEONARD S., Second Lieutenant, Air Service Aeronautics, U. S. Army, assigned to Wilbur Wright Field, Dayton, O.

MULLERGREN, ARTHUR L., Lieutenant, Quartermaster Department, U. S. Army, Camp Funston, Kan.

MUNSON, CHARLES C., First Lieutenant, Air Service, Aircraft Production, U. S. Army.

O'ROURKE, F. W., Private, Enlisted Ordnance Corps, U. S. Army, assigned to Ordnance School of Explosives Manufacture, Columbia University, New York

PEACOCK, HOWARD G., Private, 3rd Chemical Battalion, U. S. Army, Edgewood Arsenal, Edgewood, Md.

PORTER, L. L., Ensign, U. S. Navy.

PRICE, A. M., Captain, Ordnance Department, U. S. Army.

ROE, J. W., Major, Air Service, Aircraft Production, U. S. Army.

SHIRLEY, HARVEY J., Machinist's Mate, 2nd class, U. S. Navy; attached to Student Army Training Corps, Navy Section, Cincinnati, O.

SLAUGHTER, W. B., JR., Master Engineer, U. S. Army, Searchlight Depot, American Expeditionary Forces, France.

SMITH, CAMERON O., Major, Ordnance Department, U. S. Army; assigned to the New York District Ordnance Office.

SMITH, HARRY R., Candidate, 30th Trench Battery, Field Artillery Corps Officers' Training School, Camp Zachary Taylor, Ky.

SPOFFORD, HARRY H. R., Ensign, U. S. Navy; assigned to U. S.S. *Mercury*.

STANTON, R. B., JR., First Lieutenant, Student, Company 5, Engineer Officers' Training School, Camp Humphreys, Va.

STINSON, KARL W., Second Lieutenant, School of Military Aeronautics, U. S. Army, assigned to Princeton University, N. J.

STUBER, A., First Lieutenant, Signal Corps, U. S. Army.

THAYER, PAUL W., PRIVATE, Co. D, First Replacement Regiment Engineers, Washington Barracks, Washington, D. C.

TURNBULL, M. J., First Lieutenant, Engineers' Corps, U. S. Army.

WALKER, CHARLES A., Second Lieutenant, R. E., British Expeditionary Forces, France.

WHITCRAFT, ARTHUR, Captain, Ordnance Department, U. S. Army.

WHITE, EDWARD F., Lieutenant, U. S. Navy.

Women's Auxiliary of the A. S. M. E.

The Women's Auxiliary of the Society, coöperating with the Council of Organizations for War Service, offers opportunities for service in the centers established by the Section on Aliens, listed below. The officers of the Auxiliary hope to interest an increasing number of women through the two thousand members residing in the Metropolitan District and further information may be secured from the chairman of the Auxiliary, Mrs. Charles Ethan Davis, 885 West End Avenue, New York, N. Y.; telephone Academy 3167.

In New York City: Arnold Toynbee House, 331 East Broadway; Music School Settlement, 55 East Third St.; Emanuel Brotherhood, 309 East Sixth St.; Public School No. 74, 220 East Sixty-third St.

In Brooklyn: Brownsville Library, Glenmore Ave. and Watkins St.; Brownsville Children's Library, Stone and Dumont Aves.; Bushwick Library, Bushwick Ave. and Seigel St.; De Kalb Library, Bushwick and De Kalb Aves.; East Library, Arlington Ave. and Warwick St.; Eastern Parkway Library, Eastern Parkway and Schenectady Ave.; Greenpoint Library, Norman Ave. and Leonard St.; Kings Highway Library, 1608 Kings Highway; Leonard Library, Devoe and Leonard Sts.; Ridgewood Library, 496 Knickerbocker Ave.; Saratoga Library, Hopkinson Ave. and Macon St.; South Library, Fourth Ave. and Fifty-first St.; Williamsburgh Library, Division and Marcy Aves.; Winthrop Library, North Henry St. and Engert Ave.

Assistants are also desired for other branches of the Council's work, such as War Camp Community Service centers, baby-saving campaigns, etc. Details may be obtained from Miss Bernays at the Council's headquarters, 18 West Thirty-fourth Street, New York, N. Y.; telephone Knickerbocker 365.

At the Engineer Officers' Training School

A member of the Society who is in touch with the requirements of the officers' training schools offers the following suggestions for prospective applicants:

To those of our membership who are contemplating applying for engineer officers' commissions, a few notes on their status while in training will be instructive.

The embyro officer receives from the Adjutant-General a telegram appointing him a commissioned soldier, whereupon he puts a snug-fitting uniform decorated with bars or oak leaves and castles, and proceeds to Camp A. A. Humphreys, Virginia, chest well puffed out.

After reporting at the E. O. T. S. headquarters he becomes rapidly disillusioned as to his importance, and finds before nightfall that so far as the camp is concerned he is just a buck private. For the first four weeks he will receive daily about seven hours' infantry drill instruction, which will include the manual of arms, pack drill, bayonet drill, tent pitching, guard, outpost and reconnaisance duties. The rest of the course will be occupied with military engineering, such as bridges, pontoons, trench and dugout building, demolitions, military law, field service regulations, administrations.

The student officer will then take his turn at acting as commander or other officer.

The important point which all students should grasp at once is this: Their ability as engineers is not questioned and it is taken for granted that they are really capable; but what the army needs is *soldiers*, and it is the duty of the commanding officer in charge of the training school, and his assistant instructors, to make the men into soldiers. This means discipline, knowledge of warfare and, in the case of officers, the ability and personality to be in command of men.

LIBRARY NOTES AND BOOK REVIEWS

REVIEWS of books of special importance to mechanical engineers by members of the Society and those particularly qualified, brief descriptive notes of accessions to the Library of the United Engineering Society, items of interest relating to the Library's activities, etc.

CONCRETE STONE MANUFACTURE. By Harvey Whipple. Concrete-Cement Age Publishing Co., Detroit, 1918. Cloth, 5 x 7 in., 318 pp., 82 illus., 104 pl. $1.50.

A textbook for manufacturers of factory-made concrete units, based on the practice of various successful enterprises. Discusses plant layout, operation, methods, materials, finishing, building regulations, tests, etc.

FRENCH-ENGLISH AND ENGLISH-FRENCH DICTIONARY OF AVIATION. By Robert Morris Pierce. N. Y. Languages Publishing Co., New York, 1918. Paper, 4 x 7 in., 12 pp. $0.60.

A brief bilingual dictionary of words and phrases, with the pronunciation carefully indicated.

GUIDE TO THE USE OF UNITED STATES GOVERNMENT PUBLICATIONS. By Edith E. Clarke. The Boston Book Co., Boston, 1918. Cloth, 6 x 9 in., 308 pp. $2.50.

A guide to the history, use, cataloguing and classification of United States government publications. Written primarily for librarians and library workers, it is broad enough in scope to serve as a laboratory manual for all who use the government publications inside libraries and out. Contains four bibliographies dealing with different phases of the subject.

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA. Giving Shipping Weights, Capacities, Outputs and Net Prices of Machines and Apparatus, and Detailed Costs of Installation, Maintenance, Depreciation and Operation, together with Many Principles and Data Relating to Engineering Economics. By Halbert P. Gilette and Richard T. Dana. First Edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible Cloth, 5 x 7 in., 1734 pp., illus. tables. $6.

This handbook is similar in method to the authors' two previous handbooks covering costs in the field of civil engineering and can be used to supplement them. It is almost entirely devoted to purely electrical and mechanical subjects. Chapters on general economic principles, depreciation, repairs and renewals are included.

CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT. With Mechanical Equipment Directory. Standardization Work of the Society, List of Transactions Papers, and Engineering Data are included. Eighth annual volume, October 1918. N. Y., The American Society of Mechanical Engineers. Cloth, 6 x 9 in., 812 pp., illus.

This edition of Condensed Catalogues has been enlarged by approximately thirty per cent. Four hundred and fifteen firms are represented by publication of catalogue data constituting a gain of nearly 100 firms as compared with the 1917 volume. The general directory of mechanical equipment has also been expanded to include over 3700 firms, classified under more than 2700 topics, and the directory of consulting engineers has been enlarged and improved. A subject list of the papers that have appeared in the thirty-nine volumes of the Transactions of the Society is included, together with a selection of engineering data from the Journal of 1917 and a summary of the Society's work on engineering standards. The volume is designed to be a primary reference work for buyers and users of mechanical equipment, giving the engineers specific data to assist in the selection of suitable machinery for various purposes.

MODERN NAVIGATION BY SUMNER-ST. HILAIRE METHODS. The First Published Work Devoted Exclusively to the Elucidation of This Subject, Now So Generally Used in the U. S. Navy. By Frank Seymour Hastings. Appleton & Co., New York, 1918. Cloth, 4 x 6 in., 84 pp. $0.75.

Presents the methods used in the Navy in an elementary form. Contains the merchant-marine method, the Sumner method and the Marcq St. Hilaire method. Intended as a supplement to the authors' Navigation—A Short Course.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by November 15 in order to appear in the December issue.

CHANGES OF POSITION

RALPH E. CARPENTER has assumed the duties of director of service with the Aluminum Castings Company, Cleveland, O. He was formerly associated with The Taft-Peirce Manufacturing Company, Woonsocket, R. I., in the capacity of sales manager.

WILLIAM T. WATERS, formerly connected with the Illinois Central Railroad, Chicago, Ill., as mechanical inspector, has become associated with Kehm Brothers Company, Chicago, Ill., and is now in charge of their contract for power and process piping at the U. S. Nitrate Plant, No. 3, Toledo, O.

ROBERT I. CLEGG has been appointed New England editor of *The Iron Age*. He was, until recently, vice-president of the Gardner Printing Company, Cleveland, O.

DAVID A. CHAPMAN, formerly vice-president of the Dangel Company and the Touraine Company of Boston, is now with the U. S. Shipping Board as supervising engineer in charge of the training of chief engineers for turbine-driven ships, with headquarters at 173 Milk Street, Boston, Mass.

LOUIS J. SECKELS of the United Filters Corporation, San Francisco, Cal., has accepted the position of assistant engineer with the Oregon Short Line Railroad Company, Salt Lake City, Utah.

E. N. BATES, JR., assistant professor of mechanical engineering, Pennsylvania State College, State College, Pa., has become associated with the office of Grain Standardization, Bureau of Markets, Washington, D. C.

CLIFFORD LEE, formerly mechanical engineer, India Rubber Company, New Brunswick, N. J., has become affiliated with the Hercules Powder Company, Nitro, West Va.

FRANK C. SPENCER, until recently efficiency engineer, Western Electric Company, Chicago, Ill., is now connected with The Colt Patent Fire Arms Company, Hartford, Conn., in the capacity of superintendent of the Browning Gun Department.

STANWOOD W. SPARROW has left the employ of the Robert T. Pollock Company, Boston, Mass., to become associate engineer at the Bureau of Standards, Washington, D. C., in charge of the work in the altitude laboratory.

W. VAN ALAN CLARK, until recently engineer of plants, Tuco Products Corporation, Chicago, Ill., has entered the employ of the U. S. Shipping Board, Emergency Fleet Corporation, Philadelphia, Pa.

WILLIAM H. GRIFFITHS, leading designer, Department 29, Pratt and Whitney Company, Hartford, Conn., has accepted a position with the Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn.

R. RENTON HIND has become affiliated with the Pacific Commercial Company, Manila, P. I. He was formerly connected with the Honolulu

Iron Works Company, Honolulu, Hawaii, in the capacity of consulting sugar-house engineer.

ALBERT WHATMORE has been appointed chief engineer, Erith Oil Works, Ltd., Erith, Kent, England. He was formerly chief assistant engineer, The Olympia Oil and Coke Company, Ltd., Selby, York, England.

VINCENT C. GEORGE, formerly instructor, Pennsylvania State College, State College, Pa., has been associated with the Engineering Extension Division, University of Wisconsin, Madison, Wis.

WILLIAM L. DOTEN, formerly mechanical engineer with The Lamson Company, Boston, Mass., has assumed similar duties with the Sturtevant Mill Company,, Dorchester, Mass.

J. W. BRUSSEL, until recently supervisor of machining at the Dayton Engineering and Laboratories Company, has accepted the position of superintendent with the Wright-Martin Aircraft Corporation, Long Island City, N. Y.

EDWIN F. CHURCH, JR., formerly professor of machine design, West Virginia University, Morgantown, W. Va., has assumed the duties of professor of mechanical engineering, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

IRA B. DOLE, until recently connected with the Federal Creosoting Company, Bound Brook, N. J., in the capacity of agent, has become affiliated with the American Creósoting Company, of Hugo, Okla.

WILLIAM MULHERON, until recently associated with Westinghouse, Church, Kerr and Company, New York, has become connected with the Chester Shipbuilding Company, Ltd., Philadelphia, Pa.

ROY B. FEHR has resigned his position as assistant professor of mechanical engineering at Pennsylvania State College, State College, Pa., to become assistant physicist for the Recording and Computing Machine Company, Dayton, Ohio.

M. R. WALTON, formerly works manager of the Pennsylvania Salt Manufacturing Company, Natrona, Pa., is now employed as mechanical engineer with the Firestone Steel Products Company, Akron, Ohio.

GEORGE M. KEENAN has become identified with the Lehigh Navigation Electric Company, Allentown, Pa. He was formerly connected with the Little Rock Railway and Electric Company, Little Rock, Ark., in the capacity of chief engineer.

C. A. HOLDRIDGE, formerly factory manager of the Metalwood Manufacturing Company, of Detroit, Mich., has assumed the duties of mechanical superintendent of the Chalkis Manufacturing Company, Detroit, Mich., who are making 3-in. anti-aircraft guns for the United States Government.

CHARLES L. FREDERICK, formerly vice-president and general manager of the Passaic Metal Ware Company, Passaic, N. J., has assumed the duties of general manager of the Thurlow Steel Works, Chester, Pa. Mr. Frederick has recently had his Christian name changed, by order of the court, from Karl to Charles.

ANDREW WESTWATER has resigned his position as chief engineer of the G. M. Standifer Construction Company, Vancouver, Wash., and has opened an office at Seattle, Wash., as consulting marine engineer and naval architect. Mr. Westwater has been appointed consulting marine engineer and Pacific Coast Representative of the General Ordnance Company, Denver, Colo., which is now using its shops for building marine engines and auxiliary machinery for marine service.

FRANK H. CROCKARD, late president of the Nova Scotia Steel and Coal Company, and formerly vice-president and general manager of the Tennessee Company, has returned to Birmingham district as president of the Woodward Iron Company.

JOHN J. CHISHOLM has started on his duties as superintendent of power for the Woodward Iron Company. He was formerly superintendent of power of New Orleans Railway and Light Company, New Orleans, La.

ANNOUNCEMENTS

In the 1918 Year Book the address and business connection of A. L. ROBERTS (1909), should have been listed as follows: Designing Engineer, Bethlehem Steel Company, Bethlehem, Pa., and for mail, 17 N. Centre Street, Bethlehem, Pa.

HOWARD M. GASSMAN will act as associate chief fuel conservator for the State of Alabama.

EDWARD G. JAY, JR., has accepted the position of hull fittings engineer with the American International Shipbuilding Corporation, Hog Island, Pa. Mr. Jay will, however, still maintain his consulting engineering office in Philadelphia, Pa.

ARTHUR H. MORSE has accepted the position of supervisor of technical training in the War Education Department of the University of Cincinnati, Cincinnati, O.

JOHN CALDER, who for a year after returning from France was engaged in organized seaplane production on a quantity basis at Keyport, N. J., has resigned as vice-president and generaal manager of the Aeromarine Plane and Motor Company of that city, and has assumed his consulting practice in industrial reports, organization and management at 35 West 39th Street, New York. Mr. Calder is also actively identified with the development of an all-steel airplane and has recently been elected vice-president of the Boyd Motors Corporation, controlling it.

VICTOR J. AZBE has terminated his connections with the Anheuser Busch Brewing Association, and has opened a consulting engineering office at 2194 Railway Exchange Building, St. Louis, Mo. His work will be in the direction of general power-plant efficiency.

LEON B. JONES, assistant engineer of the gas department of the Pacific Gas and Electric Company, San Francisco, Cal., has enlisted as a private of engineers in the United States Army. Mr. Jones has devoted much time and thought recently to the extraction of toluol from manufactured gas, and has been active in assisting the gas defense service of the United States Army.

MISS KATE GLEASON has assumed the presidency of the First National Bank of East Rochester in the absence of H. C. Eyer, former president, who has left for Europe to engage in Y. M. C. A. work. Miss Gleason is probably the first woman to become president of a national bank of issue.

EDGAR BUCKINGHAM, of the Bureau of Standards, has been appointed physical associate to the scientific attaché to the American embassy at Rome.

APPOINTMENTS

W. J. ARMSTRONG, manager of the crushing and pulverizing sales department of the Jeffrey Manufacturing Company, Columbus, O., has recently received an appointment as Captain in the U. S. Army, and has been assigned to the Ordnance Department in Washington, D. C.

HERBERT B. REYNOLDS, formerly mechanical assistant to superintendent of motive power of the United Railways and Electric Company, Baltimore, Md., has been appointed fuel engineer, U. S. Bureau of Mines.

CHARLES E. WADDELL, of Asheville, has been appointed chief of conservation for North Carolina.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT POSITIONS

Stamps should be inclosed for transmittal of applications to advertisers; non-members should accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

PRODUCTION, PLANNING AND SCHEDULING ENGINEERS to act as assistant shop superintendents in the Hull Division. Salary to start $6 per day. Location, New York. G0513-K.

ORDNANCE DEPARTMENT desires men as Directors of Training Departments to develop intensive training of workers in their factories at Philadelphia. G0667-K.

CHIEF INSPECTORS having considerable shop experience on steel and forging work and on machining of steel and trench warfare material. Positions will pay from $2500 to $3000 per annum, but men of considerably high calibre than seems commensurate with these salaries are asked to assist in this work. Location, Cincinnati District Ordnance Office. G0672-K.

SHOP INSPECTORS ON BARBETTE CARRIAGES are desired by Maryland Plant. Position requires engineer having had experience in the assembly of heavy machinery, in gathering and consolidating complete data from the rough forging or casting to finished carriage, also data of shop maneuvering tests before shipment. Salary $2400 per annum. G0673-K.

CONSTRUCTION DIVISION desires men as City Managers and assistant to officer in charge of Military Camps of 40,000 men. Men must possess initiative to meet all emergencies of maintenance and repair, and ability to command working force of 400 to 950 men. Prefer men over 40 years of age with administrative experience in operation of public utility properties. Although the salary is not commensurate with ability, the need for responsible men is urgent. G0681-K.

INSPECTORS AND PRODUCTION ENGINEERS. Large engineering concern requires the services of several men to inspect and expedite the production of electrical and mechanical apparatus on Government and essential work. Reply quickly, stating age, education, brief outline of experience, salary expected and when available. Location, New York City. G0687-K.

ENGINEERS from 30 to 35 years of age having general manufacturing experience on mechanical work desired by plant in West

Virginia. Position temporary, about 3 months, with possibility of becoming permanent. Salary $200-$250 per month. G0690-K.

UNITED STATES RAILROAD ADMINISTRATION desires draftsmen on power-plant design. Salary $120-$175 per month. Location, New York City. G0691-K.

DETAIL DRAFTSMEN AND DESIGNERS. Munitions Plant in Brooklyn desire services of two men. Salary to start $30 per week. G0695-K.

ORDNANCE DEPARTMENT desires two experienced mechanical engineers for experiment and development work on munitions and fuses. Salary $250 to $350 per month. G0702-K.

DRAFTSMEN. The Navy Department is desirous of obtaining the services of draftsmen. Salary commensurate with ability. Location, Washington. G0717-K.

ASSISTANTS in important research work in the fatigue of metals, especially as applying to war problems, such as aircrafts, crank shafts and electric welding of ships. Investigations to be carried on at own laboratory or at laboratory in Middle West. G0719-K.

DESIGNERS AND DRAFTSMEN for experiment station. Positions would exempt from draft. Salaries for designers up to $185 a month; for draftsmen up to $115. Location, Connecticut. G0739-K.

FOREST SERVICE. Engineers and assistant engineers are desired. Salary for engineers from $1800 to $3000; assistant engineers from $1500 to $1800. Location, Middle West. G0744-K.

HULL DRAFTSMEN. Those having experience in wooden hulls preferred. Location, New York. G0747-K.

NAVAL GUN FACTORY needs technical graduates who are competent designers of jigs, tools and gages. Salary $4 to $6.88 per day. Location, Washington. G0748-K.

MECHANICAL AND SAFETY ENGINEER having two or more years' practical shop experience. Must be tactful and able to confer with high executives and Government officials. Excellent opportunity to make wide acquaintance in engineering profession. Salary $1800 to $2500. Apply by letter. Name will not be given in this record. G0767-K.

CIVILIAN POSITIONS

BIG OPPORTUNITY in an old-established business for practical man who can offer a few specialties for manufacture, one with combination of mechanical and executive ability understanding sheet-metal and light-screw machine work and who can develop sheet-metal specialties that can be marketed to afford volume production to the factory. Location, New York. K-0460.

ELECTRICAL ENGINEERS on plans and specifications. Some drafting. Americans wanted. Salary $1200, $1400 or higher if necessary. Location, New York Central. K-0718.

SALES ENGINEERS in various district offices. Air-compressor manufacturer. State qualifications, experience if any, and compensation expected. K-0216.

MECHANICAL ENGINEER. Excellent opportunity for technical man with shop and drafting-room experience with growing concern in Connecticut making high-grade specialized product. Work interesting and carries considerable responsibility. Give full particulars. K-0257.

ASSISTANT TEST ENGINEER, technical graduate not subject to draft, with experience in steel heat-treatment and testing work for growing concern in Connecticut making high-grade specialized product; knowledge of chemistry an advantage. Good opportunity and work interesting. Give full particulars in answering. K-0258.

INSTRUCTOR IN MECHANICAL ENGINEERING to teach descriptive geometry, machine drawing, some laboratory work, and elementary steam engineering. Salary $1800 per year. Location, Ohio. K-0433.

MECHANICAL ENGINEER with experience in design, testing, and general engineering work in connection with small and medium steam turbines. Must have good business and executive ability, reduction-gear experience also desirable and be able to handle variety of work in connection with steam turbines and turbine-driven machines. Give full details of training, experience and salary expected. Photograph desirable. Location, Connecticut. K-0464.

MECHANICAL ENGINEER with machine-shop experience for position similar to master mechanic. Salary, $50 to start. Location, Brooklyn. K-0468.

PROFESSOR OF MECHANICAL ENGINEERING in charge of department, technical graduate with both teaching and practical experience. Give full statement of training and experience, references and late photograph. Salary $240 per month for next ten months. Location, Idaho. K-0471.

MECHANICAL ENGINEER AND DESIGNER with extensive experience in the design and construction of shipbuilding cranes, derricks, drag-line excavators and similar work. High-grade man wanted to take charge. Location, Pennsylvania. K-0475.

DRAFTSMAN, high-grade man with experience on boiler design. Salary $175 to $225. Location, Pennsylvania. K-0482.

DRAFTSMAN, high-grade man with experience on locomotive-crane design. Salary $175 to $225. Location, Pennsylvania. K-0483.

DRAFTSMAN, high-grade man with experience on the design of steel towboats and barges. Salary $175 to $225. Location, Pennsylvania. K-0484.

SEVERAL FIRST-CLASS DRAFTSMEN with broad engineering experience. Good future for right men. Location, Ohio. K-0496.

THREE ENGINEERS, experienced in substituting mechanical equipment for hand labor. Must be familiar with all kinds of conveying equipment. Good future for right men. Location, Ohio. K-0497.

ASSISTANT MECHANICAL ENGINEER familiar with general machinery in machine shop and mill engineering; must be competent to lay out and direct installation of new machinery and direct repairs and alterations on present equipment. Concern manufacturing mechanical rubber goods and employs about 2000. Technical graduate preferred. Salary $1500 to $2000, depending on man. Location, Massachusetts. K-0498.

MECHANICAL ENGINEERS AND DRAFTSMEN for designing machinery wanted by large and long-established company, located near New York City. K-0502.

TURBINE DESIGNER, experienced, capable of taking complete charge of design and construction of turbines and reduction gears, wanted by large and long-established company, located near New York City. K-0503.

DRAFTSMEN AND DESIGNERS, experienced in calculating automatic machinery, typewriters, etc. Permanent positions offered to competent men. Location, New York City. Salary about $35 per week. K-0512.

MECHANICAL ENGINEER, five years' experience or better for gas and fuel company. Salary $175 to start. Location, Colorado. K-0669.

DRAFTSMEN AND TRACERS, electrical and mechanical engineers for plant layout work. K-0670.

CHECKER on patterns and drawings. Prefer man with textile-machinery experience, although not absolutely essential, if experienced with other lines of machines. Location, Boston. K-0671.

MECHANICAL ENGINEER to supervise completion and later maintenance of Government plant on power side, requiring some construction expeerience, heat, light, sanitary distribution of power and electrical engineering. Splendid opportunity for right man. Location, New Jersey. K-0675.

DRAFTSMAN on power building and power-plant piping. Salary depends on man. K-0676.

DRAFTSMAN on layout of crushing and ore plant. Transmission work, elevators and conveyors. Salary depends on man. K-0677.

DRAFTSMEN familiar with foundation plans, arranging of machinery and shop equipment in connection with large extension to plant. Rate approximately $1.00 per hour. Time and a half for overtime beyond eight hours. Location, Camden, New Jersey. K-0678.

POWER-HOUSE ENGINEER to study operating conditions, repair and execute plans and methods for increasing economy, in power house of 6,000 kw. generating capacity, serving an essential industry. Excellent opportunity for advancement to position of assistant chief engineer for man with executive ability. State full details of education and experience, age, draft status and salary expected. Location, Detroit. K-0683.

MECHANICAL ENGINEER in connection with construction and maintenance department of large manufacturing plant executing only Government orders. Applicant must be competent to study and design heating and steam-distribution problems, air-conveyor systems, installation of motors, line shafting and conveyor for handling materials. Technical education desirable but not necessary. Give full details of education and experience, age, nationality, draft standing and salary expected. K-0684.

ASSISTANT ESTIMATOR on minor buildings, alterations, rearrangements and items of equipment in large manufacturing plant executing war orders. Ability to make free-hand sketches necessary but skill as a draftsman or technical education unnecessary. Position affords opportunity for advancement in construction and maintenance department. State experience, age, nationality and draft status. Information confidential. Location, Detroit. K-0685.

CHIEF DRAFTSMAN capable of taking charge of drawing room employing three or four men, in designing equipment, minor buildings and rearrangements in large manufacturing plant, engaged exclusively in war work. Technical education or expert skill as designer unnecessary. Must be thoroughly practical and experienced in factory arrangement and operation. State education, experience in detail, age, draft standing and salary expected. Information confidential. Location, Detroit. K-0686.

EFFICIENCY ENGINEERS with at least one year's experience; preferably college men, mechanical, electrical or civil engineering training. Salary $125 to $175 with yearly bonus amounting to 60 up to 90 per cent of year's salary, depending on earnings of company. Location, New York. K-0688.

JUNIOR ENGINEERS, three, willing to learn efficiency engineering; preferably college men, mechanical electrical or civil engineering training. Salary $100 to $125 per month with yearly bonus amounting to 60 up to 90 per cent of year's salary, depending on earnings of company. Traveling involved. Draft exempt. Location, New York. K-0689.

WORKS MANAGER for plant located in New Jersey manufacturing several lines of specialties, must have broad general business experience and good judgment and be familiar with modern duplicate parts manufacture. Preferably technical graduate who has worked with up-to-date productions, central controlling and planning system.

Man capable of earning $6,000 to $7,000. Position will develop to general manager and possible opportunity for acquiring substantial interest in company, if services are satisfactory. Location, New York. K-0693.

COMBUSTION ENGINEER who will go to the bottom of things and give some logical solution of power-plant troubles in paper mills. Young progressive man or older man beyond the draft age; some drafting, designing, etc. Good opportunity. Liberal salary, depends generally on the ability of man. Location, Middletown, Ohio. K-0696.

YOUNG MECHANICAL ENGINEER as assistant to consulting engineer for a large nationally-known manufacturing concern. Must be technical graduate and in deferred classification under selective service act. Experience in heating and power-plant engineering desirable. Work is directly connected with the war work; position permanent with excellent opportunities for advancement. Location, New York City. Outline experience and state salary expected. K-0699.

METALLURGIST. Preferably with smelting experience in copper or lead, either civil or mechanical. Salary from $3500 to $5000. Headquarters, New York. K-0700.

DRAFTSMEN in shipbuilding line. Location, Staten Island. K-0701.

MECHANICAL DRAFTSMEN, 10 on industrial plant layout. Salary $30 to $50 per week. Location, New York. K-0704.

INDUSTRIAL DRAFTSMEN, three; salary $30 to $50 per week. Location, New York. K-0705.

TRACERS, three, about $30 per week. Headquarters, New York City. K-0706.

MACHINE SHOP FOREMAN, competent to supervise lathes, milling, boring, and screw-machine hands. Salary $2800 per year. Location, Philadelphia. Apply by letter. K-0709.

INSTRUCTOR for steam engineering. Location, Seattle, Washington. K-0710.

HIGH-CLASS MECHANICAL ENGINEER having both the training and experience which will fit him to act in the capacity of chief engineer to master mechanic of plant, capable of taking care of the mechanical power and refrigerating engineering connected with a packing house. If qualified to have charge of all the construction work as well as the engineering end. Location, Ohio. K-0711.

COMBUSTION ENGINEER for large industrial plant in South operating 12,000 hp. steam plant; state technical training, practical experience and salary earned and expected, together with copies of references. K-0712.

MECHANICAL DRAFTSMAN (women with necessary qualifications will be accepted) with some experience in building construction. Experience in furnace-combustion work preferred. Permanent position. State age, experience and salary expected. Location, New York City. K-0714.

CHIEF ENGINEER capable of handling new 16,000 kw. turbine-driven steam-power generating station. Position is with public service corporation. Requires man who can take complete charge of the plant, looking after its economical operation and maintenance. No duties other than operation of plant. Location, Philadelphia. K-0716.

ELECTRICAL ENGINEERS on plans and specifications. Some work on drafting board. Americans wanted. Salary $1200, $1400 or higher if necessary. Headquarters, New York City. K-0718.

TWO MECHANICAL DRAFTSMEN with piping experience. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0720.

FOUR MECHANICAL DRAFTSMEN with industrial-plant experience. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0721.

TWO MEN with reinforced concrete experience. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0722.

FOUR MEN, structural-steel designers. Salary as high as $60 per week, depends on man. Location, Wilmington, Del. K-0723.

SEVERAL MEN to inspect and expedite the production of electrical and mechanical apparatus on government and essential work for large engineering concern in New York City. Apply quickly, stating age, education, brief outline of experience, salary expected and when available. K-0724.

SALES ENGINEER, technically-educated man, preferably between ages of thirty and forty, with successful experience in sales problems in metal-manufacturing industries. Liberal salary and interesting, patriotic work for one with right qualifications, which must include a vigorous personality and ready command of written English. In reply, state age, college or technical school, date and degree, whether married or single, specify chronologically account of business experience, present and expected salary. Location, Boston, Mass. K-0725.

COMPETENT BOILER INSPECTOR, to be employed by Hawaiian Sugar Planters' Association, for inspection of boilers of sugar mills and pumping plants, locomotives, etc., on members' plantations. Must understand boiler-insurance companies' requirements. State training, experience, references, and salary expected. K-0726.

EMPLOYMENT DIRECTOR for a small machine shop building engines for Government work. Location, Western Pennsylvania. Man thoroughly competent to get men, keep them, and arrange for the training of unskilled labor to enable it to do skilled machinist's work. Permanent position and good salary. New York concern. K-0727.

APPRAISERS for number of manufacturing properties. Salaries would depend on qualifications of applicants. Philadelphia concern. K-0728.

ELECTRICAL AND MECHANICAL ENGINEER. Under civil service law. Position will pay about $3,300 per year at the start and $3,600 as soon as incumbent has fully demonstrated ability to satisfactorily handle work. Includes operation, maintenance and repair of electric lighting system for boulevards and parks, including high-tension transformer sub-stations, and transmission lines, and all auxiliary apparatus; also design, maintenance and repair of illuminating equipment in all park buildings. Preparation of plans and specifications for alterations and new electrical construction work and supervision of their execution will also be included. Location, Illinois. K-0729.

APPRAISER on general machinery, machine shop and all mechanical machinery. Salary $1500 to $3000. Headquarters, New York City. K-0730.

SUPERINTENDENT for metal-stamping plant in Alexandria, Indiana. Man should be experienced in both metal-stamping and screw-machine work, also die and tool making. About 200 men employed in plant devoting 95 per cent of its production to war orders. K-0731.

PRODUCTION MANAGER who is able to deserve by his ability and experience, a salary of $9,000 or $10,000 per year. Needs to be a good production manager in the fullest sense of the word. K-0732.

DESIGNING ENGINEER in charge of drafting and design work in connection with the application of roller bearings to all kinds of industrial apparatus. Age 26 to 40. Thoroughly familiar in machine shop and drafting room on heavy machinery design. Location, New York City. Salary $2000. K-0733.

SUPERINTENDENT OR PRODUCTION MANAGER. Quality of handling men and system of more importance than mechanical ability. Location, Connecticut. K-0743.

CHIEF OPERATING ENGINEER to have charge of the power plant, 9000 hp., 3250-kw. capacity, an additional steam plant for heating and industrial purposes of about 400 hp., large hydraulic pump room giving power for benches, rams, etc., and several other centres of steam-using apparatus. Salary about $3000 a year. Location, near New York. K-0745.

GENERAL FOREMAN in plant department to have charge of from 150 to 200 men, made up of electricians, plumbers, steamfitters, carpenters, painters, laborers, etc., who would be responsible for the maintenance and construction work in a plant employing about 3000 hands. Position about $3000 a year. Plant is running between 90 and 100 per cent for the government, mostly on direct orders for the Army and Navy. Location, near New York City. K-0746.

ENGINEERS to train and develop in the fundamentals of firm primarily engaged in the distillation of coal tar with resultant principal production of bituminous road and roofing materials, with the ultimate object of filling operating positions in various plants as foreman, head chemist, assistant superintendents, or superintendents. Preferably men of chemical engineering training, but not essential. As contemplated work will eventually be of an executive nature, ability to handle men is a desirable asset. Location, New York. K-0749.

SALESMAN for special class of machinery. Man with technical training and ability to meet the engineering staffs of large organizations. Location, Ohio. K-0750.

DESIGNERS on tools, jigs and fixtures. Salary $40 a week. Location, Brooklyn, New York. K-0751.

DRAFTSMEN experienced in construction and repair of machinery for industrial plants, qualified to design special machinery and making layouts of new equipment. Prefer men with chemical-plant experience or who have done drafting for consulting engineer. Permanent position in an essential industry with 40 per cent of plant devoted to government work. State qualifications and details of past experience. Salary $1400 to $1600 to start. K-0752.

ELECTRICAL ENGINEER principally for shop inspection and to superintend the erection of electric monorail and traveling-crane equipment, with incidental miscellaneous office and field work. Man in class 2D, 3 or 4 of the draft. K-0753.

DRAFTSMAN to do all-around work connected with engineering department. Metallurgical and chemical concern. Location, New York. K-0754.

ASSISTANT EMPLOYMENT MANAGER, man with some mechanical training. Appointment can be made through New York office. Location, Connecticut. K-0288.

DRAFTSMEN for Connecticut plant. Men of recognized ability desired. Appointment can be made through New York Office. K-0289.

TIME-STUDY WORK, men of ability. Location Connecticut. K-0290.

YOUNG ENGINEER over draft age, single, to go to head office in Chile, S. A., of company operating several plants in nitrate district. Should have some experience in industrial cost analysis and efficiency work, in addition to general engineering experience. Salary $3000 a year to start. K-0316.

DRAFTSMAN for proposition department. Design of power-house and boiler-rooms and making estimates of costs, as an aid to sales department. Believe opportunities for young men of ability are exceptional. Location, New Jersey. K-0207.

FIRE PROTECTION ENGINEER. Large plant in Detroit requires man to guard

against fire hazards. Should be fully informed as to modern fire-prevention methods, with sufficient training and education in electricity and chemistry to fully appreciate hazards of this sort. In applying, state age, draft status, nationality, extent of education, detailed experience, present employment, etc. K-0247.

CONTROLLING INTEREST in prosperous machine-tool and gage manufacturing concern to be sold for best offer. Present owner to enter service. Well known firm of wide reputation. Location, Connecticut. K-0259.

CAPABLE PRACTICAL MAN to take entire business control of machine shop building special machinery, gages and tools. Engineer with business knowledge and experience in this line of work preferred; interest in the business may be acquired by the right man. Location, Connecticut. K-0260.

SALESMAN familiar with sale, design and making of special machinery, tools, gages and fixtures; practical mechanical experience necessary. Good opening for right man. Location, Connecticut. K-0261.

ENGINEERS, college graduates, men out at least a year, for general shop engineering work with growing concern. Work leads to industrial management. State full particulars. Location, New Jersey. K-0265-E.

EXPERIENCED COPY WRITER to handle building construction and equipment accounts. Exceptional opportunity with New England agency for man who knows the contracting field and can show satisfactory evidence of ability through copy and catalogue matter already written. K-0267.

MECHANICAL DRAFTSMEN with technical education, experienced on vacuum-heating systems and high-pressure steam piping. Location, New York. K-0329.

DRAFTSMEN with experience in conveying machinery and general engineering. Salary, $175 to $200. Location, New Jersey. K-0336.

TOOL MAKERS OR MACHINISTS. Location, Newark, New Jersey. K-0341.

DRAFTSMEN, some experience in chemical plants. Location, New York City. K-0346.

MECHANICAL DRAFTSMEN experienced in power-transmission and machinery-arrangement work. Work in question will probably be over two months' duration and good salaries will be paid competent men. Traveling expenses from New York to West Virginia and return, and living quarters furnished without charge. K-0347.

MECHANICAL DRAFTSMEN in electrical department of large railroad company. Men familiar with large power-station work. Immediate work in hand is installation of a 20,000 kw. turbo-generator with the necessary condensing apparatus, boilers, stokers, coal and ash handling apparatus, etc. Salary, $174 per month. Location, New York. K-0352.

MACHINE DESIGNERS on fixtures, jigs, etc., flat salary of $25 and opportunities at high rates by the hour. Location, Connecticut. K-0353.

SALES ENGINEER, energetic and willing to work. Must be thinker with engineering college degree, one year shop work on machine design, or a high-school education with two or three years shop work on machine design. Between 25 and 32, draft exempt, or class 4. Salary $1500 to $1800. Location, New York as headquarters to travel. K-0355.

DRAFTSMEN on power-house layout and piping. Salary depends on man. Location, New York. K-0382.

DRAFTSMAN on marine-engine work in factory having large Government contract. Permanent employment for the right party. One having oil engine experience preferred. Location, New York State. K-0384.

SHIPBUILDING DRAFTSMEN. Salary, $35 to $40. Location, Brooklyn, N. Y. K-0386.

TURBINE-MAINTENANCE ENGINEER. Man for inspection of turbine and auxiliary equipment and taking care of the major repairs to apparatus, for large power company operating several stations. Location, Pennsylvania. K-0412.

BOILER-MAINTENANCE ENGINEER. Man for inspection of boiler and boiler-room apparatus. One with construction experience in large boilers preferered. Location, Pennsylvania. K-0413.

SUPERINTENDENT for growing concern having machine shop, foundry, pattern and blacksmith shop just starting on attractive specialty, requires capable superintendent experienced in above lines, and a good systematizer. Excellent opportunity for young man. Location, Michigan. K-0417.

SALES ENGINEER having thorough technical and practical knowledge in electrical work, telephone equipment and installation and equipment of electrical apparatus in general, to travel Pacific Coast for New York corporation. Man between 25 and 35, having good personality and appearance coupled with selling ability, preferably in class 4A of draft. Knowledge of shipbuilding industry is desirable. Traveling expenses paid. Salary, drawing account plus commission. K-0692.

EXPERIENCED COKE OVEN OPERATOR and supervising gas-works engineer in city near Atlantic seaboard, where residence conditions are agreeable and excellent schooling and college education available for children. Write, giving in detail experience and technical education, references, expected salary and how soon available. Applications will be considered confidential. An excellent permanent position for the right man. K-0742.

HIGH-CLASS MAN who has combined engineering and selling ability. Location, Buffalo, New York. K-0755.

ASSISTANT ENGINEER with technical training and experience in construction and repairs of industrial plants, qualified to design special machinery and capable of making layouts of new equipment so as to obtain efficient utilization of floor space and economical plant operation. Permanent position. Prefer man with experience in chemical plant or office of consulting engineer. State qualifications and details of past experience. Salary, $1500 to $2000, according to ability. Location, Southern Ohio. K-0756.

MECHANICAL DRAFTSMAN in engineering department in our New York office. Pay $150 to $175 per month for man capable of doing detail work and light designing. Location, New York. K-0757.

NEW YORK FIRM OF INDUSTRIAL AND SCIENTIFIC MANAGEMENT ENGINEERS desires to take into their engineer staff with purpose of training, men who are draft exempt for work classified as "essential" by a number of District Boards and by the Provost General's office. Splendid training is given in production increasing and management work in large variety of industries, together with opportunity for managerial position. K-0758.

DRAFTSMAN experienced in mill and power piping, all classes of heating. Man over 36 years of age or else with dependents. Location, Massachusetts. K-0760.

SALES ENGINEER, prominent pumping machinery concern desires to add four men to its sales organization, to sell centrifugal pumps and steam turbines. Only men who know machinery, who are versed in the pump and turbine atmosphere, and who are fully conversant with the engineering problems involved in erection and operation of centrifugal pumps and steam turbines will be considered. Liberal salary plus commission on each sale and choice of four sales territories, namely New York, Philadelphia, Detroit, or Boston, is offered. Location, New York. Apply by letter. Name confidential. K-0761.

ELECTRICAL AND MECHANICAL ENGINEER. Position will pay about $3300 per year at the start and $3600 per year as soon as the incumbent has fully demonstrated his ability to satisfactorily handle the work. Under civil service law. Work includes operation, maintenance and repair of electric lighting system for boulevards and parks, including high-tension transformer sub-stations, and transmission lines, and all auxiliary apparatus; also the design, maintenance and repair of illuminating equipment in all park buildings. Preparation of plans and specifications for alterations and new electrical construction work and supervision of their execution will also be included. Location, Illinois. K-0729.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MEMBER, mechanical engineer, technical education, 12 years' experience plant layout, structural steel, timber construction, conveying, elevating, power-transmission machinery. Now in sole charge work involving expenditure $200,000 designing, purchasing materials, directing field work. Minimum salary $350 month. K-261.

TECHNICAL GRADUATE with 10 years' experience in steam and hydraulic power-plant design and construction work, desires position with concern engaged in essential business, also plant-operation and plant-machinery installation work. K-262.

EXECUTIVE ENGINEER, M. I. T. graduate, Member, 20 years' experience along mechanical electrical lines, and in organizing and purchasing. American; location preferred, New York City or vicinity. K-263.

CHIEF DRAFTSMAN OR PRODUCTION ENGINEER, 10 years' experience as draftsman, designing, motors, jigs, tools, plant layout, furnaces, charge of machine-shop production, efficiency, at present on consulting work; position desired in New York City, Newark, or vicinity. Salary $180 to $200 per month. Married, three dependents, American, 33 years of age. K-264.

DESIGNING AND MAINTENANCE ENGINEER. Mechanical engineer, University of Pennsylvania graduate, desires connection as designing engineer or chief draftsman with concern where merits would be appreciated. Past experience includes design, erection and maintenance of large industrial and power-plant installations in supervising capacity. At present engaged as designing engineer. K-265.

PRODUCTION ENGINEER, competent in plant and production equipment, open for engagement preferably in metropolitan district. K-266.

WORKS MANAGER OR ASSISTANT. Graduate of Purdue University, degree of M.E.; 18 years' experience in freight car work. Experienced in heavy presses, steel and hydraulic presses. Designer of dies for heavy pressing. Familiar with tank car construction and maintenance. Location, middle west preferred, but other location considered if the inducements are there. Married, over 36, probably draft exempt. K-267.

MECHANICAL ENGINEER desires executive position offering greater opportunities than present position as works engineer for large company. Member, age 38, married. Technical graduate, practical experience in carpentry, plumbing and machine shop. Drafting experience in mining machinery, power pumps and electrical machinery. Engineering experience covers power-plant work, both generation and distribution. Repair and maintenance, new construction and industrial work in general, especially equipment for pattern, wood, box-making and machine shops, iron and brass foundries, grinding, polishing, buffing, hardening, japanning, coslittizing, electro-plating and other special processes. In charge of work relative to compensation and labor laws,

welfare, safety, watchmen's and firemen's organization, public relations. Can handle big propositions and large numbers of men successfully. K-268.

SALES ENGINEER having business-getting record is open for engagement as manager of sales, in charge of responsible district office or on a basis in line with experience and qualifications. Can give satisfactory evidence of ability and character. Change is contemplated because of present conditions curtailing activities. K-269.

TOOL SUPERINTENDENT, ASSISTANT CHIEF ENGINEER, CHIEF DRAFTSMAN. Progressive, energetic engineer, desires to make connections with manufacturing concern needing an engineer with training and broad experience as well as ability to produce results. Excellent references, open for engagement about December 1. K-270.

PRODUCTION OR PRODUCTION EQUIPMENT ENGINEER, or other responsible position, designing or manufacturing end or both. Must be war work. Salary about $4000. Would like to correspond with party needing self-starting man. Practical mechanic and designer. Experience covers originating, designing, building and operating numerous special and standard automatic and semi-automatic machines for producing wide variety of articles from wire, sheet metals, paper, wood, etc., for assembling labor saving, processing, conveying, cost reducing, etc. Punches and dies, jigs, fixtures and tools and general engineering, routing, cost accounting, bookkeeping, time study and production. 28 years old, married with family, draft exempted. Will go anywhere. K-271.

INDUSTRIAL AND SALES ENGINEER possessing ability to supervise plant manufacturing iron and steel products, specializing in power-house equipment. Trained mechanical engineer, experienced in purchasing, designing, manufacturing and sales promotion. Able to take entire charge of business and successfully market product, desires permanent executive position to start about $6000 and advance rapidly as results are shown. American, 40, married, with family, very successful record and large earning capacity. K-272.

INDUSTRIAL ENGINEER, designer, complete experience from shop apprentice to sales agency, technical graduate, 43 years of age, married, faultless record, will go anywhere, especially coast district in south. K-273.

MECHANICAL ENGINEER, age 24, wishes position preferably in Middle West. K-274.

MECHANICAL ENGINEER, now chief engineer of an industrial car company, desires position with manufacturing company, as mechanical engineer, or other executive position. Ten years' experience in general mechanical engineering. Thoroughly conversant with technical and practical side of standard railway and industrial equipment. Competent to assume full charge and to produce results. Salary not less than $3600. K-275.

FOUNDRY SUPERINTENDENT OR MANAGER, thoroughly practical, iron, brass, and composition foundry man, having wide experience on all classes of iron and brass castings. Over draft age; satisfactory references furnished, also satisfactory reason for wishing to make change from present position. K-276.

TECHNICAL EXECUTIVE with broad American and foreign experience desires position abroad, preferably in reconstruction work in France or England. American-born, college graduate, associate member, age 31, Class 4. Experience as engineer and executive in production, design, tool-work, organization, and management. Well-balanced, resourceful, dependable. Salary $8000 to $10,000. K-277.

POWER-PLANT EXECUTIVE. Technical graduate, age 31, Class 4 of draft, with 10 years' experience in power-plant construction, reconstruction, operation and management, desires position of this nature more directly connected with war work. At present employed. Salary considered $3600 to $4000. K-278.

MECHANICAL ENGINEER. Member, age 45, married, technical graduate. 20 years' experience, covering design, construction, operation of cement plants. Thoroughly conversant with boilers, engines, turbines, motors; at present superintendent of large plant, wants to change for larger responsibilities; will go anywhere, available any time. K-279.

PRODUCTION ENGINEER. Thorough experience in planning, dispatching, cost system. Analytical, creative ability and tact rated the highest. Age 32, 4th class draft. Salary $5000. K-280.

TECHNICAL GRADUATE with over ten years' experience in design, construction, operation and maintenance of manufacturing and power equipment is desirous of making new connection as mechanical engineer or in other executive capacity in line with his qualifications. Capable and conscientious worker with the best of references. Minimum salary $3600. K-281.

EXECUTIVE, 38, desires connection where mechanical training, including 18 years in design, development, manufacture, sale and installation of boiler room equipment would be of service; traveled extensively, familiar with fuel problems, excellent correspondent, hard worker. Chicago preferred. K-282.

INDUSTRIAL OR PUBLIC UTILITY EXECUTIVE, member, technical graduate, age 46, American, Protestant. Unusual combination of general business, financial and engineering experience. Thoroughly grounded in mechanical and electrical engineering, including design, construction, operation, examinations, appraisals, utilities and industrial undertakings. Especially successful in organizing and directing large working forces for construction and operation in different sections of the country where local conditions and labor problems differ greatly. A profit-sharing arrangement with a small enterprise that has a future or salary commensurate with ability. K-283.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER NOVEMBER 21

BELOW is a list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of applications 164.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by November 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

DEMPSTER, WILLIAM J., Fuel Agent, Montgomery Light & Traction Co., Birmingham

JONES, GEORGE W., Draftsman, Republic Iron & Steel Co., Birmingham

California

AUSTIN, HENRY W., Senior Mechanical Engineer, Interstate Commerce Commission, San Francisco

KINGWELL, WILLIAM A., Owner, Brass Foundry & Machine Works, San Francisco

LLOYD, BRUCE, Manager, Engineering Dept., Henry Lund & Co., San Francisco

Connecticut

MURPHY, FREDERICK H., Assistant Superintendent, Remington Arms U. M. C. Co., Bridgeport

District of Columbia

BELLONY, ALEXANDER M., Captain, National Army, War Dept., Washington

BLACKWOOD, JOSEPH H., Mechanical Expert & Patent Attorney, Washington

BREARLEY, JAMES A., First Assistant Examiner, U. S. Patent Office, Washington

MILLER, ELTON W., Mechanical Expert, Chemical Warfare Service, War Dept., Washington

SIMPSON, FREDERICK, Assistant Mechanical Engineer, Quartermaster Corps, U. S. A., Washington

Florida

HUDSON, FRANK L., U. S. Shipping Board, Jacksonville

Illinois

BAUEREISEN, RALPH J., Well Contractor, Partner, C. P. Brant & Co., Chicago

CASBERG, CARL H., Assistant to General Superintendent, Rockford Drilling Machine Co., Rockford

ELLIS, RUSSELL E., President, R. E. Ellis Engineering Co., Chicago

EXTON, ALFRED H., Chief Engineer, American Manganese Steel Co., Chicago Heights

FISHER, FRED, Vice-President & Treasurer, R. E. Ellis Engineering Co., Chicago
GARDNER, LESTER H., Supt. Engineering & Planning, Rock Island Arsenal
GREEN, J. BIRCHARD, President, Chicago Steel & Wire Co., Chicago
JOHNSON, CLARENCE G., Consulting Engineer, Union Utilities Co., Chicago
KEHM, AUGUST, President, Kehm Bros. Co., Chicago
MAY, HARRY C., General Superintendent, Chicago, Indianapolis & Louisville R. R., Chicago
MUELLER, JACOB W., Managing Estate of Solomon Mueller, Belleville
SONEN, CLAYTON L., Industrial Engineer, L. V. Estes, Inc., Chicago

Indiana

ADDINGTON, MARTIN L., Tool & Gauge Maker, Nordyke Marmon Co. Indianapolis
BESSOM, EARL A., Chief Engineer, Wheeler Schebler, Carburetor Co., Indianapolis

Iowa

JACOBSON, ERNST, Consulting Engineer, Davenport

Maryland

MITCHELL, GEORGE W., U. S. Army Chemical Warfare Section, Edgewood Arsenal, Edgewood

Massachusetts

CHANDLER, LEONARD D., Member of Firm, Rideout, Chandler & Joyce, Boston
APPLEGATE, WILLIAM A., Chief Draftsman, Morgan Construction Co., Worcester
KNOWLES, FRANK E., Superintendent of Inspections, Factory Mutual Insurance Co.'s., Boston
LEARY, FRANCIS J., Hydraulic Engineer, Chas. W. Praray, New Bedford
LUSK, WALTER F., Chief Steam Engineer, American Writing Paper Co., Holyoke

Michigan

HANDLOSER, ROBERT C., Manager, Branch Office, Motch & Merryweather Mchy. Co., Detroit
HEATH, LEWIS W., Treasurer, General Manager, Consolidated Press Co., Hastings
LEWIS, JOHN G., Vice-President & Factory Manager, Detroit, Screw Works, Detroit
MORRISSEY, JOHN M., Field Superintendent & Service Engineer, Diamond Power Specialty Co., Detroit

New Jersey

KOPF, EMIL A., Assistant to Mechanical Engineer, Singer Mfg. Co., Elizabeth
MEEKS, HOWARD V., Treasurer, The Gardner & Meeks Co., Union
MURPHY, TIMOTHY J., Field Engineer, American Steel & Wire Co., Trenton
WATTS, GEORGE A., JR., Salesman, General Utility Man, Watts Campbell Co., Newark

New York

BERNDT, IRVING A., Vice-President, C. E. Knoeppel & Co., Inc., New York
BORSUK, ANTON, General Superintendent, Presto Machine Works, Brooklyn
CHAMBERLAIN, REGENALD P., Tool Designer, Pierce Arrow Motor Co., Buffalo
COFFEY, BARTON H., Chief Engineer, Cooling Tower Co., Inc., New York
EDWARDS, HARRY D., Chief Draftsman, The Linde Air Products Co., New York
EVANS, LEIGH R., Vice-President & Factory Manager, Cyclemotor Corp., Rochester
FEILD, WILLIAM T., Construction & Maintenance Engineer, American Car & Fdry. Co., Depew
FLIFLET, THORLEIF, Chief Engineer, Walter Kidde & Co., Inc., New York
FREE, ALBERT V., Assistant to Principal in Charge of Academic Work, Saunders Trades School, Yonkers
GRIMMER, FREDERIC H., Machine Shop Superintendent, Cameron Machine Co., Brooklyn
HOPF, HARRY A., Consulting Industrial Engineer, New York
KELLER, M. W., Manager, Engineering & Research Dept., Oneida Community, Ltd., Kenwood
KNAPP, ARTHUR, President, Arthur Knapp Engineering Corp., New York
LOPPIN, ALEXANDER J., Assistant to Superintendent, Fidelity & Casualty Co. of New York, New York
MCCULLOUGH, CHARLES H., JR., Vice-President & General Manager, Lackawanna Steel Co., Buffalo
MANVILLE, KEITH R., Designer, Curtiss Engineering Corp., Long Island City
NEUBAUER, GEORGE A., Mechanical Engineer, The Buffalo Pitts Co., Buffalo
PACKARD, ROLAND A., Superintendent of Power, Barnet Leather Co., Little Falls
SEARLE, ERNEST M., Mechanical Engineer, Standard Oil Co. of New York, Albany
SHAFFER, MATTHEW T., Mechanical Engineer, The Barrett Co., New York
THOMAS, EDWARD H., Chief Inspector of Chemical Plant Construction, Ordnance Dept., U. S. A., New York
VAN GORDER, WINFRED H., Superintendent, C. J. Tagliabue Mfg. Co., Brooklyn
VUILLEUMIER, RUDOLPH, Chief Engineer, Pintsch Compressing Co., New York
WHITAKER, HARRY E., Engineer, Ford, Bacon and Davis, New York

North Carolina

MAULDIN, EARLE, Engineer of Construction, R. J. Reynolds Tobacco Co., Winston-Salem
MEISTER, CONRAD L., Mechanical Engineer, A. C. L. R. R., Wilmington

Ohio

ANDERSON, HAROLD, N., President, Anderson Rolled Gear Co., Lakewood
CASE, ALLANDO A., Instructor, Machine Shop Practice, Ohio State University, Columbus
DRAKE, WILLIAM A., Secretary and Sales Manager, The Brownell Co., Dayton
GARDNER, ROLLAND, Commercial Engineer, Westinghouse Elec. & Mfg. Co., Cleveland
JONES, SIDNEY W., Inspector, New Construction, Youngstown Sheet & Tube Co., Youngstown
KEYS, WALTER C., Acting Director of Engineering, The Standard Parts Co., Cleveland
KNECHT, ARTHUR E., Production Engineer, National Cash Register Co., Cincinnati
MORRIS, GEORGE M., President & Treasurer, The Morris Machine Tool Co., Cincinnati
PILLIOD, CHARLES J., Designer, The Pilliod Co., Swanton
SHIELDS, FRANK S., President, The Cleveland Planer Co., Cleveland

Pennsylvania

AUSTIN, WALTER M., Electrical Engineer, Westinghouse Elec. & Mfg. Co., E. Pittsburgh
BROSIUS, EDGAR E., Contracting Engineer, Pittsburgh
CUNNINGHAM, OTTO H., Charge of all fuel and power conservation work, Allegheny Steel Co., Breckenridge
FULLER, JOHN T., Mining Engineer, Aluminum Co. of America, Pittsburgh
HUGHES, HARRISON H., Master Mechanic, Carnegie Steel Co., By-Product Coke Wks., Clairton
KLINE, CHAS. W., Draftsman, New Jersey Zinc Co., Palmerton
MERRITT, JAMES S., Philadelphia Manager, The Engineer Co., New York Philadelphia
SCHRANZ, CHARLES A., Manager, Hydraulic Machinery Dept., R. D. Wood & Co., Philadelphia
SLOAT, BENJAMIN C., Div. Superintendent of Hull Construction, American Internation Shipbuilding Corp., Hog Island
SULLENBERGER, JOHN K., Construction Engineer, Bethlehem Steel Co., Bethlehem
WRIGHT, RAYMOND D. B., Sales Engineer, Harrison Safety Boiler Woorks, Philadelphia
ZINK, JOHN H., Construction Engineer, Bethlehem Steel Co., So. Bethlehem

Texas

BASTION, J. A., Construction Engineer, The Texas Co., Port Arthur
WILSON, CHESTER W., Consulting Engineer, American Smelting & Refining Co., El Paso

Virginia

TOPHAM, WILLIAM O., Superintendent Engineer and Engineer, Surveyor Shipping Control Committee, Newport News
WEIDMAN, WILLIAM R., Captain Engineers, 547th Service Battalion, Camp A. A. Humphreys

Washington

BOUSCHOR, WILLIAM E., Puget Sound Manager, Williamette Iron & Steel Wks, Seattle
FLODIN, JOHN, Draftsman, C. M. Standifer Construction Corp., Vancouver
MATHESON, W. SCOTT, Vice-President and Manager, Westerman Iron Wks., Seattle

West Virginia

STEVENSON, CHARLES M., Works Engineer, Rollin Chemical Co., So. Charleston

Wisconsin

NAGLER, FORREST, Sales Engineer, Allis-Chalmers Mfg. Co., Milwaukee

Canada

WOOD, REGINALD H., Lieutenant, Chief Engineer, Esquimalt Naval Dockyard, Esquimalt, B. C.

England

JOHNSON, LAWRENCE W., Consulting Engineer & Technical Director, Messrs. Banks, Warner & Co., Ltd., London

France

PIERCE, PAUL L., Lt. Col., Ordnance Dept., U. S. N. A., American Expeditionary Forces

Mexico

TAYLOR, WILLIAM R., Chief Mechanical Engineer, Mexican Eagle Oil Co., Minatitlan

South America

MCINTYRE, OTIS L., Mechanical Superintendent, Cerro de Pasco Copper Corp., La Fundicion, Peru

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Arizona

BUCHEN, JOSEPH C., Mechanical Engineer, Miami Copper Co., Miami

California

CARTER, THOS. F., Mechanical Engineer, Western Pipe & Steel Co., Los Angeles

New York

INGLEE, CLINTON, Treasurer & General Manager, National Water Main Clearing Co., New York
LAPP, ROY B., Plant Engineer, Ingersoll Rand Co., Painted Post
PAVITT, WILLIAM H., Assistant Chief Engineer, Wilputte Coke Oven Corp. New York

Ohio

SCHUTTLER, CARL H., Assistant District Supply Manager, U. S. Shipping Board Emergency Fleet Corp., Youngstown

Pennsylvania

FLETCHER, HOWARD J., Production Manager, Miller Lock Co., Frankford

Washington

MAGUIRE, WALTER J., Chief Inspector, Pacific Coast Steel Co., Seattle
SEIM, OLIVER P., Dispatcher, Navy Yard Puget Sound, Bremerton

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

HOUGHTON, HARRY S., Construction Engineer, C. F. Braun & Co., San Francisco

Connecticut

HUMASON, LAWRENCE C., Secretary & Treasurer, The Peck & Young Mfg. Co., Forestville
MERRY, ARTHUR A., Assistant Works Manager, Pratt & Whitney Co., Hartford

MILLINGER, WILLIAM A. F., Assistant Engineer, American Can Co., Bridgeport

District of Columbia

ABRAMS, LAWRENCE B., Engineer, Ingersoll-Rand Co., Washington
MAIER, DWIGHT C., Aeronautical Mechanical Engineer, Bureau of Aircraft Production, War Dept., Washington

Illinois

FISCHER, FRANZ W., General Superintendent, The Liquid Carbonic Co., Chicago

Massachusetts

GEORGE, HARRY A., Chief Cost Accountant, The Heald Mch. Co., Worcester

Michigan

BAITS, STUART G., Engineer, Hudson Motor Car Co., Detroit

New Jersey

MULLER, JOSEPH, Mechanical Designer, Crocker-Wheeler Co., Ampere
REITZEL, JACOB H., Rate-Setter, Crocker-Wheeler Co., Ampere

New York

BAUMEISTER, PAUL A., Mechanical Engineer, Ingersoll-Rand Co., New York
LAHRS, LOUIS J. T., Director of Physical Education, Y. M. C. A., Buffalo
LEINROTH, JEAN P., Foreman of Welding Dept., Bossert Corp., Utica
MARTIN, WALTER H., Small Tool Engineer, Arthur Knapp Engineering Corp., New York
NEWBY, CLARENCE L., Engineer, Hyatt Roller Bearing Co., New York
PIPEROUX, RENE P., Chief Estimating Engineer, Honolulu Iron Wks., New York
STEELE, FRANCIS J., Jr., Assistant Chief Draftsman, Naval Auxiliary Reserve, New York
WILLIAMS, HARRY H., Safety Engineer, Wynkoop Service, New York

Ohio

FELLOWS, JOHN A., Assistant Superintendent, Machine Dept., American Rolling Mill Co., Middletown
TOESSER, LEO P., Production Engineer, The American Rolling Mill Co., Hamilton
WHITMAN, RAY B., Assistant to Chief Inspector, U. S. Shipping Board, Emergency Fleet Corp., Cleveland

Pennsylvania

KLEIN, STEPHEN L., Superintendent, Lykens Valley Fuel Co., Williamstown
SHEPHEARD, GEORGE R., Assistant Chief Engineer, The Viscose Co., Marcus Hook

Wisconsin

FRASER, JOHN, Jr., General Manager, The Fraser Co., Milwaukee

Canada

McKINNON, R. A., Factory Manager, McKinnon Industries, Ltd., St. Catherines

Hawaii

SEMPLE, DAVID M., Works Manager, Catton Neill & Co., Ltd., Honolulu

FOR CONSIDERATION AS JUNIOR

California

COBERLY, CLARENCE J., Engineer, California Burdett Oxygen Co., Los Angeles

Connecticut

NELSON, RALPH M., Assistant Mechanical Engineer, Ashcraft Mfg. Co., Bridgeport

Delaware

GROW, HAROLD J., Assistant Foreman, Welding Dept., Bethlehem Shipbuilding Corp., Wilmington

District of Columbia

OLIVER, HERMAN G., Experimental Engineer, Science & Research Div., U. S. A., Washington

Georgia

McGOWN, CLARK Y., Ordnance Dept., U. S. A., Camp Hancock

Indiana

STILZ, OSCAR W., In Charge of Production Dept., Nordyke & Marmon Co., Indianapolis

Maryland

HINE, RUSSELL C., Steam Engineer, Consolidated Gas, Electric Light & Power Co., Baltimore

Massachusetts

BLUE, EDWARD W., Scovell, Wellington & Co., Boston

Missouri

SIROKY, EDMOND, Instructor in Mechanical Engineering, Washington University, St. Louis

New Jersey

CHANDLER, SHERMAN M., Assistant Engineer, Standard Aero Corp. of New York, Plainfield
EDWARDS, WILLIAM W., Millwright, Dusenberg Motors Corp., Elizabeth

New York

ANDERSEN, ANDREAS H., Manager, A. Hermansen, New York Branch, New York
CETRULE, JOHN, Chief Inspector, Blair Tool & Mch. Wks., Inc., New York
DOXSEY, ARTHUR M., Assistant Engineer of Tests, Hull Division, Navy Yard, New York
HAUSEL, WALTER M., Assistant to Chief Draftsman, Otis Elevator Co., Yonkers
HYDE, GEORGE G., Assistant Engineer of Design & Construction, Eastern Potash Corp., New York

Ohio

WHITE, THOMAS H., Assistant to Vice-President, White Motor Co., Cleveland
WUEST, FRANK W., Assistant in Planning and Time-Study Dept., The Lodge & Shipley Mach. Tool Co., Cincinnati

Oregon

FERRELL, FRED C., General Foreman, Spokane, Portland & Seattle Ry., Portland

Pennsylvania

BRITTON, HOWARD, Jr., Representative, Brass Goods Dept., Manning, Maxwell & Moore, Inc., Pittsburgh
NICHOLAS, JOHN E., Shop Engineer, Bethlehem Steel Co., Bethlehem
RABE, FREDERICK W., Condenser Test Floor Engineer, Westinghouse Elec. & Mfg. Co., Wilkinsburg
TEFFEAU, LOUIS M., Mechanical Draftsman, A. I. S. B. Co., Philadelphia

France

LEISTER, FAYETTE, Master Engineer, 103rd Engineers, U. S. A., American Expeditionary Forces
PAULES, PARVIN E., Lieutenant, Aviation Section

CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Michigan

STANBROUGH, DUNCAN G., General Superintendent, Packard Motor Car Co., Detroit

New York

PRICE, MELVIN, Assistant Professor of Machine Design, University of Rochester, Rochester

PROMOTION FROM ASSOCIATE-MEMBER

Missouri

RUPP, MANNING E., Superintendent, Shell Forging Plants, Curtis & Co. Mfg. Co., St. Louis

New Jersey

KING, FRANK A., Construction Engineer, Wright-Martin Aircraft Corp., New Brunswick

New York

HAMPSON, DONALD A., Mechanical Executive, Morgans & Wilcox Mfg. Co., Middletown
OBERG, ERIKE V., Editor, "Machinery," New York

PROMOTION FROM JUNIOR

District of Columbia

FOGLER, BEN B., Major, Mechanical Research, Chemical Warfare Service, Washington

Massachusetts

HERRICK, DANIEL A., General Superintendent, Julian d'Este Co., Boston

Mississippi

SHARP, JOHN T., Superintendent, Canton Elec. Light & Water Wks., Canton

New Jersey

MOON, ALFRED G., Maintenance Engineer, Hercules Powder Co., Kenvil

New York

LINKER, ABRAHAM, Designer on Industrial Plant, Perin & Marshall, New York
McMILLAN, LUTHER B., Consulting Engineer, H. W. Johns-Manville Co., New York
MANDEL, ARTHUR C., Engineering Dispatcher, Wright-Martin Aircraft Corp., Long Island City
OSBOURN, MILLARD P., Chief Engineer, Badenhausen Co. (Reinstatement), New York
REBER, JAMES B., Superintendent, Columbian Rope Co., Auburn
VAN DERVORT, ADRIAN O., Superintendent, Hammett Machine Works, Troy

Pennsylvania

PRIEBE, ERNEST B., Chief Draftsman, Stoker Eng. Dept., West. Elec. & Mfg. Co., E. Pittsburgh

SUMMARY

New Applications	164
Applications for change of grading:	
Promotion from Associate	2
Promotion from Associate-Member	4
Promotion from Junior	11
Total	181

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT OCTOBER 24, 1918

Average age of applicants:	
Members	39
Associates	38
Associate-Members	32
Juniors	25
Aeronautical Mechanical Engineer	1
Associate Editor	1
Chief Engineer	2
Assistant Chief Engineer	1
Consulting Engineer	2
Designers	3
Draftsmen	2
Chief Draftsmen	3
Executives (Pres., Vice-Pres., Secy., Treas., Mgrs.)	20
Foreman	1
Inspector	1
Assistant Inspector	1
Instructor	1
Master Mechanic	1
Mechanical Engineers	14
Assistant Mechanical Engineers	2
Motor Engineer	1
Operating Engineer	1
Plant Engineer	1
Production Officer	1
Professor	1
Resident Engineer	1
Sales Engineer	1
Superintendents	5
Assistant Superintendent	4
Miscellaneous	17

UNITED STATES GOVERNMENT SERVICE

Major	1
1st Lieuts.	2

SELECTED TITLES OF ENGINEERING ARTICLES

THE section Selected Titles of Engineering Articles comprises an index to current articles on mechanical engineering and related subjects.

This work has been made possible by the remarkable collection of current technical periodicals available in the Library of the United Engineering Society, which is one of the greatest and most complete collections in the world. The Library receives, even now, when some of the foreign periodicals have ceased to come to its shelves, close to a thousand different papers, magazines and transactions of societies in the engineering and scientific fields, in not less than ten languages. The Society's engineering staff examines these publications as they are received and prepares the cards which are ultimately used in the Selected Titles section of THE JOURNAL.

Chief attention is paid to articles directly concerned with the branches of mechanical engineering. When it is thought they will be of interest or value to mechanical engineers, however, other articles are listed, in the realms of physics and chemistry; civil, mining and electrical engineering, technology, etc.; and in subjects in broadly related fields such as training and education, safety engineering, fire protection, employment of labor, welfare work, housing, cost keeping, patent law, public relations, etc. Cross-references are introduced and where the titles themselves are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC PRINTS

Photostatic copies may be obtained of any of the articles listed in this section.

Price of each print (up to 11 x 17 in. in size), 25 cents, plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Orders should be sent to

HARRISON W. CRAVER, *Director,*
Engineering Societies Library,
29 West Thirty-ninth Street,
New York.

AERONAUTICS

Aerostatics

Military Aerostatics, H. K. Black. Aerial Age, vol. 7, nos. 24, 25, 26, Aug. 26, Sept. 2, Sept. 9, 1918, p. 1167, 1 fig., p. 1219, p. 1267, 1 fig., vol. 8, nos. 2 and 3, Sept. 23 and Sept. 30, 1918, p. 65, 1 fig., p. 119, 1 fig. Aug. 26: Science of ballooning; Cocquot type, Model *M*, operated by Royal Flying Corps. Sept. 2: Parachute harnesses. Sept. 9: Dimensions of American observation balloons. Sept. 23: Construction of balloon winches. Sept. 30: Handling a balloon in the field.

Altitude

An Alignment Chart for Obtaining Heights from Observations of Pressure and Temperature, A. H. Stuart. Aerial Age, vol. 7, no. 26, Sept. 9, 1918, p. 1275. Constructed by solving Laplace's equation between height above datum level and pressure and temperature of atmosphere, by means of a d'Ocagne alignment chart.

Problems in Flying at High Altitudes, W. Kasperowicz (Translated from French by Augustus Post). Flying, vol. 7, no. 8, Sept. 1918, pp. 714-715. Changes produced by reduced air pressure.

Bolts

On the Strength of Bolts in Airplane Structure, John Case. Aeronautics, vol. 15, no. 252, Aug. 14, 1918, pp. 134-139, 17 figs. Formulæ and rules for design; strength of bolts, in spars and the like, when subject to transverse loads at the ends; distribution of loads between bolts holding single plate under tension; distribution of load between bolts of joint subjected to bending. (To be continued.)

Enemy Aircraft Exhibit

The London Enemy Aircraft Exhibit. The Fokker Biplane, G. Douglas Wardrop. Aerial Age, vol. 8, nos. 2 and 3, Sept. 23 and 30, 1918, pp. 68 and 87, 1 fig. and p. 130, 1 fig. Sept. 23: Data of design of captured German machine of D VII type. Sept. 30: Halberstadt two-seater.

Engines

Aluminum Pistons for German Airplane Engines, C. Vickers. Brass World, vol. 14, no. 9, Sept. 1918, pp. 258, 1 fig. Drawing and description of aluminum piston taken from a 230-hp. Benz motor of captured Aviatik biplane.

Enemy Aircraft Engines (VIII). Automobile Engr., vol. 8, no. 116, July 1918, pp. 194-199, 11 figs. 180 hp. Mercedes: cylinders and other parts; lubrication; ignition; water-circulation system; power and consumption curves.

Modern Aeronautic Engines (II), Herbert Chase. Jl. Sos. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 205-208, 17 figs. Details of Sunbeam and Rolls-Royce (English) and Hall-Scott (Am.) engines. (Concluded.)

The Design of Aeroplane Engines, John Wallace. Aeronautics, vol. 15, nos. 251 and 252, Aug. 7 and 14, 1918, pp. 116-118, 7 figs., and 141-143, 6 figs. Aug. 7: Remarks on two-cylinder engines; twin-cylinder Vee engine; horizontally opposed twin; three-cylinder; four-cylinder vertical. Aug. 14: Three-cylinder radial engines; five-cylinder radial. Determination of results. (Continuation of serial.)

The 240 H.P. 8-cylinder Mercedes. Aerial Age, vol. 7, nos. 25 and 26, Sept. 3 and 9, 1918, pp. 1220-1221, 4 figs., pp. 1270-1274, 17 figs. Sept. 3: Detailed report on design of a captured German two-seater; summary of tests; cylinders; reduction gear. Sept. 9: Crank chamber; vertical driving gear; lubrication; water circulation; water-pump test report; ignition; air pump; engine data; general analysis of weights of parts.

The 300 H.P. Maybach Aero-Engine. Engineering, vol. 106, no. 2748, Aug. 30, 1918, pp. 226-228, 17 figs. Detailed and illustrated description of the six-cylinder German engine. Also published in Engineer, vol. 126, no. 3270, Aug. 30, 1918, pp. 184-186, 7 figs. and in Flight, vol. 10, no. 36, Sept. 5, 1918, pp. 995-1000, 10 figs. Connecting rods; valve gear; cam diagram and valve timing; crankshaft. (Continuation of serial.)

Individual Types

A Fokker Biplane of Recent Type. Flight, vol. 10, no. 30, July 25, 1918, pp. 829-831, 1 fig. Details of a captured German machine.

Some New Enemy Airplanes. Aviation, vol. 5, no. 4, Sept. 15, 1918, pp. 235-237, 9 figs. Dimensions and nature of Albatros D. 5, and of Fokker D. 7. Summary from L'Aérophile, L'Aéroplane, Flight and Flying. (To be continued.)

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The Pfalz Single-Seater Fighter—160 H.P. Mercedes Engine. Flight, vol. 10, nos. 30, 31, 32, 33, July 25, Aug. 1, Aug. 8, Aug. 15, 1918, pp. 822-827, 5 figs., pp. 855-856, 3 figs., pp. 885-888, 7 figs., pp. 905-908, 5 figs. July 25: Official data; diagrams showing method of covering body with ply-wood; wing roots. Aug. 1: Mounting of the tail-plane root; details of runner. Aug. 8: Safety-belt attachment; control handle; undercarriage. Aug. 15: Wiring diagram; wing structure and arrangement. Also published in Automotive Ind., vol. 39, no. 10, Sept. 5, 1918, pp. 406-409, 7 figs.

Giant Zeppelin Airships (Les avions géants Zeppelin). L'Aérophile, year 26, nos. 15-16, Aug. 1-15, 1918, pp. 225-242, 33 figs. Plans and details of captured machine, 22 m. long, 41 m. wide. Also published in Aerial Age, vol. 8, no. 3, Sept. 30, 1918, pp. 122-125, 6 figs.

Materials of Construction

Tests of Materials Used in Aeroplane Construction (L'essai des matériaux servant à la construction des aéroplanes). Génie Civil, vol. 73, no. 10, Sept. 7, 1918, pp. 188-191, 13 figs. Machines used for verifying equilibrium of parts; details and operation of Avery elongation and rupture-testing machine; tests made on textile fabrics.

Meteorology

Some Meteorological Conditions Which Increase the Danger of Flying, C. J. P. Cave. Aerial Age, vol. 8, no. 2, Sept. 23, 1918, p. 64, 2 figs. Rain, hail and snow; lightning; fog. (Concluded.)

Model Aeroplanes

Model Aeronautical Building as a Step to Aeronautic Engineering. Aerial Age, vol. 7, nos. 23, 24, 25, 26, Aug. 19, Aug. 26, Sept. 2, Sept. 9, 1918, p. 1127, 1 fig., p. 1183, 1 fig., p. 1231, 16 figs., p. 1283, 1 fig., vol. 8, nos. 2 and 3, Sept. 23 and Sept. 30, 1918, p. 77, 3 figs., and p. 135, 10 figs. Aug. 19: Method of fastening and rigging main planes. Aug. 26: Construction of tail, rudder, fin and propeller. Sept. 2: Compressed-air motor. Sept. 9: Details of motor; tank construction. Sept. 23: Steam-engine construction. Sept. 30: Gasoline-engine principle and construction.

Ornithopter

The Ornithopter, Herbert Chatley. Aviation, vol. 5, no. 4, Sept. 15, 1918, p. 237. Possibilities and requirements of the real bird machine.

Propellers

Notes on Airscrew Analysis, M. A. S. Riach, Aerial Age, vol. 7, no. 24, Aug. 26, 1918, pp. 1173-1179, 3 figs. Analysis of changes likely to be brought about by variation in one or more of the parameters involved in hypothesis upon which is based the theory of airscrew previously outlined by writer.

U. S. Aircraft Production

Aircraft Production in the United States. Flying, vol. 7, no. 8, Sept. 1918, pp. 721-726, 738 and 744. Complete report of the Senate Subcommittee on Military Affairs.

See also Metallurgy (Aircraft); Physics (Air); Woodworking Machinery (Propeller-Shaping Machines).

AIR MACHINERY

Air Compressors

Lubrication of Air Compressors, W. H. Callan. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 575-577. Shows that most oil experts figure on heat conditions which do not exist and recommend the wrong oil.

NOTE.—The abbreviations used in indexing are as follows: Academy (Acad.); And (&); American (Am.); Associated (Assoc.); Association (Assn.); Bulletin (Bul.); Bureau (Bur.); Canadian (Can.); Chemical or Chemistry (Chem.); Electrical or Electric (Elec.); Electrician (Elecn.); Engineer [s] (Engr. [s]); Engineering (Eng.); Gazette (Gaz.); General (Gen.); Geological (Geol.); Heating (Heat.); Industrial (Indus.); Institute (Inst.); Institution (Instn.); International (Int.); Journal (Jl.); London (Lond.); Machinery (Machy.); Machinist (Mach.); Magazine (Mag.); Marine (Mar.); Materials (Matls.); Mechanical (Mech.); Mining (Min.); Municipal (Mun.); National (Nat.); New England (N. E.); New York (N. Y.); Record (Rec.); Refrigerating or Refrigeration (Refrig.); Review (Rev.); Railway (Ry.); Scientific or Science (Sci.); Society (Soc.); United States (U. S.); Ventilating (Vent.); Western (West.); State names (Ill., Minn., etc.); Proceedings (Proc.); Transactions (Trans.); Supplement (Supp.).

Persberg Installation of Hydraulic Air Compressors (Hydraulisk luftkompressoranläggning vid Persberg), Gust. Anderson. Binang till Jern-Kontorets Annaler, vol. 19, no. 7, July 15, 1918, pp. 271-296, 23 figs.

Blowers

Installation and Care of Sturtevant V D-5 Turbo-Blower, F. W. Sterling. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 480-489, 5 figs. Operating rules; enumeration of parts; emergency governor mechanism; packing; bearings; lubrication.

Test of Sturtevant Forced Draft Blower, M. C. Stuart. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 453-479, 19 figs. Performance at various speeds, steam pressures and back pressures of non-condensing vertical turbine with cone-type fan mounted on shaft directly above turbine; performance of fan at various speeds and capacities; performance of combined unit.

Compressed-Air Applications

Uses of Compressed Air in the Modern Shop, P. C. Frank. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 309-313, 20 figs. Considerations on amount of clearance, cooling of air in cylinders and action of valve, in reference to efficient operation.

Flow of Air

The Flow of Air Through Small Coal and Other Broken Material: Report to the Doncaster Coal-Owners' Committee, John T. Storrow. Trans. Instn. Min. Engrs., vol. 55, part 4, Aug.-Sept. 1918, pp. 313-317, 1 fig, and (discussion) pp. 317-323. Experiments to ascertain under what conditions the rate of flow of air through a porous material varies directly as the ventilating pressure, and not with the square root of it, as in the case in ordinary pipes.

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See Lubrication (Viscosity); Safety Engineering (Dust Inhalation); Varia (Automobile Insurance).

BRIDGES

Bridge Reconstruction

Strengthening Poughkeepsie Bridge Superstructure. Ry. Age, vol. 65, no. 11, Sept. 13, 1918, pp. 473-476, 9 figs. Engineering features of efforts to increase capacity by changing from double track to single gauntlet track accommodations.

Reinforced-Concrete Bridges

A New Type of Iron-Concrete Arch, M. Frontard. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, p. 37. Structure built by bridging gap with rails bent to curvature of arch and finishing with concrete.

The Canadian Pacific Railway's Second Track Work Between Leaside Junction and North Toronto. Can. Ry. & Marine World, no. 247, Sept. 1918, pp. 378-380, 5 figs. Features of design of 386-ft. reinforced-concrete bridge over reservoir ravine; structure supported on two abutments and five towers.

Steel Arch Bridges

The Economics of Steel Arch Bridges, Indian Eng., vol. 64, nos. 3 and 4, July 20 and 27, 1918, pp. 39-41 and 53-54. Formulæ for weights of metal in arches per linear foot of span, based on designing specifications. (Continuation of serial.)

BUILDING AND CONSTRUCTION

Camp Model Towns

Construction Camps Model Towns on Miami Flood Works. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 575-578, 8 figs. Details of plan of village and floor plans of houses; village comprises houses, schools, community halls, markets, water mains, lights and sewers.

Concrete Culverts

Standard Practice in Concrete Culvert Construction, H. Colin Campbell. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 19-20. Tables giving relation between area drained and area of waterway, and data on reinforced-concrete box culverts.

Foundations

Foundation Construction for New Station at Kansas City. Elec. Rev., vol. 73, no. 13, Sept. 28, 1918, pp. 492-493, 7 figs. Problems encountered in the work on 150,000-kw. plant on Missouri River.

House Construction

House Construction and Design. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 677-679, 7 figs. Various types and sizes of concrete houses adopted for work of reconstruction of Halifax.

Mill Buildings

Reconstruction of Consumers' Cordage Plant at Dartmouth. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 687-688, 4 figs. Description of repair and reconstruction of buildings severely damaged by Halifax explosion.

Office Building

The Office Building of the Department of the Interior, Charles Butler. Architectural Rec., vol. 44, no. 3, Sept. 1918, pp. 199-213, 17 figs. Plans and elevations.

Piles

Carrying Capacity for Various Types of Piles, H. W. Young. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 28-29. Strengths computed by Patton's formula for a 30-ft. pile under average soil conditions.

See also Power Plants (Vibration).

CEMENT AND CONCRETE

By-Products

Conserving the By-Products of the Cement Mills, W. G. Clark. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 61-62, 1 fig. Opportunities in increasing efficiency by recovery of potash dust.

Concrete Proportioning

Methods of Proportioning Concrete Based on Recent Experimental Work, D. A. Abrams. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 206-207. Notes based on author's work at Lewis Institute.

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A New Shock Resisting Concrete. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, pp. 297-298. Proportions of ingredients in concrete composed of portland cement with particles of moss, turf, or wood (pulverized or pulped), and metallic ores, with a binding liquid consisting of a soluble salt of alumina, lime and water.

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Causes of the Disintegration of Concrete, A. G. Blackie. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 200-203. Comparison of theories advanced by Montana Experimental Station, Bul. 81, Feb. 1911, and by Bureau of Standards, Tech. Paper 95, 1917, with results of work developed at Univ. of Wyoming Experimental Station, Bul. 113, Mar. 1917; account of author's tests made by determining action of various alkali solutions upon sands used locally in composition of concrete

Chemistry of Concrete, Arch. Blackie. Can. Engr., vol. 35, no. 10, Sept. 5, 1918, pp. 231-233. Former and present theories explaining the disintegration of concrete; rules for making tile; distintegrated sewers; alkali action on sands; Winnipeg water district tests. Paper before Sasketoon Section, Eng. Inst. of Can.

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Reinforced Concrete v. Salt, Brine, and Sea-Water, H. J. M. Creighton. Page's Eng. Weekly, vol. 33, no. 726, Aug. 9, 1918, pp. 66-67. Corrosion of iron reinforcement due to action of brine; probable reactions which occur when metal comes in contact with a salt solution. Paper before Faraday Soc. (To be continued.) Also published in Min. Jl., vol. 122, no. 4329, Aug. 10, 1918, pp. 473-475.

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Effect of Oil on Concrete, C. P. Bowie. Practical Engr., vol. 58, no. 1642, Aug. 15, 1918, pp. 79-80. Reports on experiments performed under auspices of So. Pac. RR. Abstracted from Oil Storage Tanks and Reservoirs, Bul. 155, Bureau of Mines, Washington.

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See also Bridges (Reinforced-Concrete Bridges); Building and Construction (Concrete Culverts); Roads and Pavements (Concrete Roads).

CHEMICAL TECHNOLOGY

Flames

Residual and Extinctive Atmospheres of Flames, T. F. Eric Rhead. Jl. Soc. Chem. Ind., vol. 37, no. 16, Aug. 31, 1918, pp. 274T-278T, 2 figs. Experimental determination of oxygen contents for flames of various gases, the inert gas employed for the extinctive atmosphere being nitrogen.

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The Recovery of Gasoline from Natural Gas, W. P. Dykema. Petroleum Rev., vol. 39, no. 841, pp. 138-140. Considerations to be made before designing a compression plant to treat natural gas from a given area. (To be continued.)

High-Temperature Processes

High Temperature Processes and Products, Chas. R. Darling. Jl. Royal Soc. of Arts, vol. 66, no. 3432, Aug. 30, 1918, pp. 635-642, 8 figs. Thermit processes and application of thermit to welding of iron and steel; electric steel smelting; fixation of atmospheric nitrogen; formation of calcium carbide; carborundum and allied substances.

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Studies on the Absorption of Light Oils from Gases, Harold S. Davis and Mary Davidson Davis, Jl. of Ind. & Eng. Chem., vol. 10, no. 9, Sept. 1918, pp. 718-725, 5 figs. Theory of washing process for the absorption of benzene vapor; determination of vapor pressure of benzene from its solution in high-boiling American petroleum oil; determination of average molecular weight of oil when dissolved in benzene by lowering freezing point; theory of washing processes for the absorption of light oil vapors.

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The Recovery of Potash as a By-Product in the Manufacture of Portland Cement, John J. Porter. Am. Fertilizer, vol. 49, no. 5, Aug. 31, 1918, pp. 58-72. Possibilities of industry; problem of liberation; solubility of potash; electrical precipitation; estimating recovery; cost calculations.

Rubber

Comparative Methods for Determining the State of Cure of Rubber, H. P. Stevens. Jl. Soc. Chem. Ind., vol. 37, no. 16, Aug. 31, 1918, pp. 280T-284T, 5 figs. Formulation of degree of vulcanization in reference to (1) percentage of combined sulphur calculated in rubber present, (2) physical properties of vulcanizate, particularly load supported per unit cross-sectional area at a given elongation, or vice-versa.

Moisture in Raw Rubber, G. Stafford Whitby. Jl. Soc. Chem. Ind., vol. 37, no. 16, Aug. 31, 1918, pp. 278T-280T, 1 fig. Records of observations made under tropical conditions on variations of water content of raw rubber and its relation to humidity of atmosphere, form of the rubber, and pressure of serum solids.

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Sulphur from Coal. Gas. Jl., vol. 143, no. 2880, July 23, 1918, p. 159, 1 fig. German feld process for simultaneous recovery of sulphur and ammonia by washing coal gas, with a solution of ammonium tetrathionate.

Sulphuric Acid

Some Observations on Sulphuric Acid Plants, New and Old (IV). Gas World, vol. 49, no. 1776, Aug. 3, 1918, pp. 18-19. Spent oxide as a source of sulphur; purification of coke-oven gas.

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The Thermal Properties of Sulphuric Acid and Oleum, Alfred W. Porter. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 373-399, 4 figs. and (discussion) pp. 399-400. Experimental data; formulæ and chart for determining heat of total evaporation for mixtures of sulphuric acid and water.

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vol. 14, no. 9, Sept. 1918, pp. 297-298, 4 figs. How railroad plant increased its capacity from 12,000 to 14,000 gal. per hr. by utilizing 100,000-gal. reservoir for storage of untreated water.

See also Cement and Concrete (By-Products); Coal Industry (Coke); Engineering Materials (Rubber); Furnaces (Nitrogen-Fixation Furnaces); Refractories (High-Temperature Research), (Volatilization).

COAL INDUSTRY

By-Products

Liquid Fuel From Coal, W. R. Ormandy. Autocar, vol. 41, no. 1195, Sept. 14, 1918, pp. 257-258, 1 fig. The interrelation of pig iron, coke and benzol; report of Coal-Conservation Committee as affecting supply of fuel to motorists.

Coke

Pressure Regulation on By-Product Coke Ovens, Frederick H. Smoot. Gas World, vol. 49, no. 1776, Aug. 3, 1918, pp. 19-20, 2 figs. Valve arrangement and exhauster regulation. (From Iron Age, July 1, 1918.)

The Manufacture of Metallurgical Coke, With Special Reference to the Recovery of By-Products, W. A. Bone. Iron & Coal Trades Rev., vol. 97, no. 2635, Aug. 30, 1918, p. 231. Appendix to final report of Coal Conservation Committee specifying quality of coal best adapted for manufacture of metallurgical coke.

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CONCRETE

(See Cement and Concrete)

CONVEYING

(See Hoisting and Conveying)

ELECTRICAL ENGINEERING

Alternators

The Behavior of Alternators with Zero Power-Factor Leading Current, F. D. Newbury. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 363-365, 3 figs. Curves showing excitation characteristics and saturation conditions required for stable self-excitation.

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Aerial Cable Construction for Electric Power Transmission, E. B. Meyer. Elec. News, vol. 27, no. 17, Sept. 1, 1918, pp. 25-27, 4 figs. Design, construction and suspension of special cable used by company supplying light and power to 170 manufacturing plants. Paper before Am. Inst. Elec. Engrs.

Control Systems

Automatically Remote-Controlled Synchronous-Motor-Generator Substation, William Thomas Snyder. Elec. Rev., vol. 73, no. 11, Sept. 14, 1918, pp. 407-409, 5 figs. Relative cost of automatic and manually-operated substation and mode of operating such a station of 100-kw. capacity.

Control System for Groups of Motors in a Cement Mill, William H. Easton. Eng. & Cement World, vol. 13, no. 5, Sept. 1, 1918, pp. 61-62, 3 figs. Group of eleven motors—nine 150 H.P. 2200-volt, Westinghouse squirrel-cage motors, driving 5½ by 22 ft. tube mills, and two 250 H.P., 2200-volt Westinghouse vertical squirrel-cage motors, cement-mill type, driving Bradley grinders, controlled by system recently installed.

Electromagnets

D. C. Lifting Magnets (Electro-aimants de levage à courant continu), J. A. Montpellier. L'Industrie Electrique, year 27, no. 628, Aug. 25, 1918, pp. 305-307, 3 figs. Characteristics of each one of the five types built by the Societé l'Eclairage Electrique.

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Insulation and Damages from Excessive Potentials (Isolation och öfverspanningsskydd), W. Borggvist. Elektroteknik, vol. 48, no. 8, Aug. 1918, pp. 95-96, 1 fig.

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Change of Specific Inductive Capacity with Temperature and Impregnation of Paper, H. C. P. Weber and T. C. MacKay. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 374-377, 2 figs. Curves showing results obtained for various substances alone and in conjunction with impregnated paper, at Westinghouse Elec. & Mfg. Co.'s laboratory.

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Electric Lighting from Three-Phase Circuits, Terrell Croft. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 44-48, 14 figs. Suggestions for laying out systems, transformers and auto-transformers; industrial applications.

Motors

A Large Rolling-Mill Motor. Elec. Times, vol. 54, no. 1398, Aug. 1, 1918, pp. 74-75, 3 figs. Features of electrification of Frodingham Iron and Steel Works.

Causes of Overheated Motors and Motor Noises, M. A. Saller. Southern Engr., vol. 30, no. 2, Oct. 1918, p. 49. Improperly fitted or tight bearings, defective oil rings, unequal air gap, small brushes.

High-Power Factor Induction Motors, Marius Latour. Elec. World, vol. 72, no. 11, Sept. 14, 1918, pp. 484-489, 19 figs. Summary of various arrangements for variable-speed motors of above description proposed in last 15 years, with particular reference to French developments.

How to Buy Direct-Current General-Utility Motors, A. Brunt. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 532-534, 6 figs. Suggestions for Buyers.

Low Over-All Cost and Continuous Production, A. F. Lewis. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 592-595, 5 figs. Factors that must be considered in purchasing, installing and maintaining induction motors designed to assist in these objects.

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The Use of Graphic Instruments in Improving the Operation of Electrical Apparatus and Reducing Cost of Maintenance, J. H. Overpeck. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 354-357, 3 figs. Forms for keeping records of motor failures.

Safety Measures

Installation and Care of Large Electrical Apparatus for Steel Mills, O. Needham. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 333-336 2 figs. Insulation protection; handling, storing, erecting and starting; operation and care.

Substations

Large Underground Synchronous Substation, R. P. Hines. Coal Age, vol. 14, no. 10, Sept. 5, 1918, pp. 434-436, 4 figs. Description of substation in bituminous coal mine and its equipment.

Largest Portable Substation Yet Produced, B. H. Lytle. Elec. Ry. Jl., vol. 52, no. 11, Sept. 14, 1918, pp. 467-468, 6 figs. Long Island Railroad's portable substation used in parallel with permanent substations to help with excessive loads or as a separate substation.

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The Essentials of Transformer Practice (XIV), E. G. Reed. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 365-367, 3 figs. Formulæ for calculations of electrical quantities in reactors with magnetic circuit either of air or iron.

Transformer Connections, Waldo Bennett. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 52-53, 9 figs. Relations of windings in single, two- and three-phase; special connections.

Transient Phenomena

Some Transient Phenomena in Electrical Supply Systems, E. W. Marchant. Jl. Instn. E. E., vol. 56, no. 276, July 1918, pp. 445-455, 17 figs. and (discussion), pp. 455-471, 7 figs. Records oscillograms taken on Liverpool Corporation electric supply system. Also tests of similar phenomena under laboratory conditions.

Turbo-Generators

High Speed Turbo-Generators. Practical Engr., vol. 58, no. 1645, Sept. 5, 1918, pp. 114-116, 6 figs. Details of construction of rotors and stators. (Continued.)

Voltage Regulation

Improving Power Factor and Voltage Regulation, J. T. Peyton. Elec. World, vol. 72, no. 11, Sept. 14, 1918, pp. 492-493, 3 figs. By using synchronous condensers, a Pennsylvania company has met increased demand without additional generating equipment and has reduced transmission losses.

See also Furnaces (Electric Brass Furnaces), (Induction Furnaces), (Resistance Furnaces); Heating and Ventilation (Electric Heating Units), (Turbo-Generator Ventilation); Machine Shop (Welding); Marine Engineering (Electrical Machinery); Military Engineering (Electrical Machinery), (Sub-stations); Steel and Iron (Electric Steel).

ENGINEERING MATERIALS

Aluminum

The Alterability of Aluminum and the Properties of Its Various Alloys, Jean Escard. Sci. Am. Supp., vol. 86, no. 2225, pp. 127-128. Factors affecting alterability; properties of commercial aluminum; alteration as determined by Le Chatelier; uses and requirements; aluminum bronzes; other alloys. From Revue Scientifique.

Asphalt

Standardization of Required Consistency for Asphalt, J. R. Draney. Good Roads, vol. 16, no. 14, Oct. 5, 1918, p. 121. Reviews present practice and suggests standardization. (Am. Soc. Mun. Improvements.)

Boiler Plates

A Cause of Failure in Boiler Plates, Walter Rosenhain and D. Hanson. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 632-636, 15 figs. Effect of grain growth; alteration of crystalline structure by mechanical deformation; some remedies. (Iron & Steel Inst., London, May 1918.)

Are There Advantages in Welding Boiler Plate? Howard L. Boyd. Power, vol. 48, no. 14, Oct. 1, 1918, pp. 504-506, 7 figs. Dangers of using metal for welding boiler plate which is of a chemical composition different from that of metal in plates. From California Safety News of Industrial Accident Commission of Cal.

Causes of Failure in Boiler Plates, Walter Rosenhain and D. Heinsen. Marine Eng. of Can., vol. 8, no. 9, Sept. 1918, pp. 225-228, 15 figs. Effect of grain growth; alteration of crystalline structure by mechanical deformation; suggested remedies. Iron & Steel Inst. paper.

Bronze

The Microstructure and Value of Manganese Bronze. Shipbuilding & Shipping Rec., vol. 12, no. 10, Sept. 5, 1918, pp. 232-234, 1 fig. Values of alloy in each of two sources of introducing manganese into bronze, copper and manganese, and ferromanganese.

Copper

The Action of Reducing Gases on Hot Solid Copper, Norman B. Pilling. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 373-374. Report of results obtained at research laboratory of Westinghouse Elec. & Mfg. Co.

Hardness

Hardness of Soft Iron and Copper Compared, F. C. Kelley. Gen. Meeting Am. Electrochem. Soc., Oct. 2, 1918, Advance Copy, Paper 3, pp. 45-48. Results of hardness tests applied by Brinell method on samples of American "ingot iron" and ordinary commercial cold-rolled copper after being similarly treated in an electrically heated vacuum furnace.

Rubber

Rubber Substitutes, Andrew H. King. India's Rubber Jl., vol. 56, no. 6, Aug. 10, 1918, pp. 145-146. Factors and limitations of: asphaltic materials; coal-tar and asphalt pitches; resinous substances; glue. (Concluded from preceding issue.)

Semi-Steel

Tracing the Development and Use of Semi-steel. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, p. 319. Uses in munition manufacture in France, and in auto and truck trade.

See also Acronautics (Materials of Construction); Refractories.

FACTORY MANAGEMENT

Compensation

Forms for Use in Recording Compensation, Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 506-508. How to keep records which will stimulate foremen and others and make it possible to ascertain the probable effect, in cost of self-insurance, of any change in legislation.

Cost Systems

Cost System for a Medium Size Foundry, D. O. Barrett. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 810-813, 11 figs. Various forms which have proved their usefulness after several years' experience following a period of financial loss.

Proper Factory Cost Accounting Methods, Joseph Mack. Am. Industry, vol. 19, no. 2, Sept. 1918, pp. 17-18. How to distribute overhead expenses. Address before International Assn. of Mfg. Photo-Engravers.

Drafting Department

Drawing-Room System in the Engineering Department, G. F. Hamilton. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 485-487, 10 figs. Method for recording drawings and insuring correction of copies sent into shop.

Organization and Wage Payment for the Drafting Department, J. B. Conway. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 555-558, 4 figs. Description of plan in practical operation under conditions similar to those set forth in the article.

Production

Graphic Production Control, C. E. Knoeppel. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 177-180, 2 figs. First of series. Underlying and basic principles.

Keeping Track of Production, H. A. Russell. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 231-234, 4 figs. Key to methods described is a summary card, the production-operation cost record, upon which are entered all vital facts in regard to progress of every manufacturing order, and upon which is also kept a running inventory of all parts in stock.

Production Comparisons, Walter D. Fuller. Gas Industry, vol. 18, no. 7, July 1918, p. 241. Methods employed for determining actual and possible production.

Rents

Overhead Rent. Gas Industry, vol. 18, no. 7, July 1918, p. 239. Plan for distributing all expenses incident to occupying buildings and grounds for manufacturing, storage and office purposes.

Salvage

Salvage at the Winchester Plant, Charles M. Horton. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 201-204, 8 figs. How scrap and spare material to annual value of millions of dollars is reclaimed and utilized.

Small Jobs

Reducing the Time Occupied in Doing the Small Job. Ry. Maintenance Engr., vol. 14, no. 9, Sept. 1918, pp. 299-302. Five discussions of work done by bridge and building departments of different railroads.

Stores

Efficiency in the Handling of Railway Supplies, Charles E. Parks. Ry. Age, vol. 65, nos. 10 and 11, Sept. 6 and Sept. 13, 1918, pp. 423-427, 3 figs., pp. 491-493. Sept. 6: Methods employed by Santa Fe in storing, handling, distributing and accounting for material. Sept. 13: Line stock; ordering material; surplus and obsolete material; inventories.

Railway Stores Methods and Problems, W. H. Jarvis. Ry. Gaz., vol. 29, nos. 6 and 7, Aug. 9 and Aug. 16, 1918, pp. 155-158, and pp. 181-184, Aug. 9: Method of dealing with invoices; four-weekly balance sheets; issuing prices. Aug. 16: Stock inventories; stores sold accounts; auditing and verification of stocks.

Waste

The Elimination of Waste. Cassier's Eng. Monthly, vol. 54, no. 3, Sept. 1918, pp. 143-149. Suggestions as to how industrial waste can be cut down and scrap material reclaimed.

See also Lighting (Factory Lighting).

FORGING

Drop Forging

Drop Forging in Automobile and Aircraft work. Automobile Engr., vol. 8, nos. 116 and 118, July and Sept. 1918, pp. 190-192, 16 figs., pp. 261-263, 10 figs. Details of typical plant, with description of modern tools necessary for drop forging and methods.

Forging Machine

Possibilities of the Forging Machine, E. R. Hagen. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 304-305, 2 figs. Uses of the upsetter machine in railroad and locomotive shops.

Fuel

Fuel Analysis of a Drop Forge Plant (1), B. K. Read. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 307-312, 3 figs. Charts showing daily fuel and power consumption, results of installing new heating equipment, steam consumption on hammers and cost of steam in dollars per hammer-hour. From paper before Am. Drop Forge Assn.

Hammer Foundations

Question of Correct Hammer Foundations, Terrell Croft. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 300-304, 4 figs. Discussion of functions of hammer foundation; results of poor installation; designs and data for different types.

Piston Rods

The Care and Maintenance of Piston Rods, G. C. Stebbins. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 298-299, 1 fig. Information regarding treating of piston rods; explanation of central oiling system and its relation to maintenance of hammers. Before Am. Drop Forge Assn.

FOUNDRY

Brass Castings

How Brass Carburetors are Molded and Cast. Foundry, vol. 46, no. 10, Oct. 1918, pp. 465-469, 10 figs. Molding machines of jar-ram squeeze type extensively employed; workmen held responsible for quality of product.

Centrifugal Casting

Casting Rings in Centrifugal Machine, E. P. Cone. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 801-807, 8 figs. Large quantity production by De Lavaud process; unusual properties of metal.

Core Sand

Suggestions on Mixing Foundry Core Sand, Robert Grimshaw. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 807. Analysis of method for securing best porosity and strength in cores.

Die Castings

The Design of Die Castings, M. Stern. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 549-551, 3 figs. Practical suggestions for designer.

Fluidity of Iron

The Fluidity of Molten Cast Iron, Matthew Riddell. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 364-366, 1 fig. Attempt to explain peculiarity of cupola observed by author, which consists in greater fluidity being obtained when the bed coke is not well lighted above the tuyeres before the blast is put on and the first iron takes long to come down. Paper before British Foundrymen's Assn.

Foreign Methods

American and Foreign Steel Foundries. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 808-809. A British comparison of French, Belgian and American steel castings; our molding and annealing called inferior.

Foundry Industry

Foundry Industry Makes Big Gain in Two Years. Foundry, vol. 46, no. 10, Oct. 1918, pp. 455-460, 7 figs. Statistics on growth of foundries.

Foundry Losses

How the Engineer Stops Foundry Losses, Stephen B. Phelps. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 209-211, 6 figs. Defective castings, a total loss of foundry labor and supplies, can be prevented by proper design.

Man Power

Your Biggest Foundry Problem—Manpower, H. Cole Estep. Foundry, vol. 46, no. 10, Oct. 1918, pp. 443-450, 13 figs. War demands more castings with less labor; machines must do work of men.

Patterns

Mounting Patterns on Plates an Aid to Molding, R. R. Clarke. Foundry, vol. 46, no. 10, Oct. 1918, pp. 451-454, 3 figs. Various methods described and their advantages and disadvantages discussed from standpoint of both foundryman and patternmaker.

Taking the Pattern Shop Out of the Attic, F. L. Prentiss. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 640-641, 2 figs. Cleveland patternmaker believes business should be banished from dingy quarters and puts his ideas into practice.

The Making of Better Patterns, Ellsworth Sheldon. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 617-629, 10 figs. Requirements of a good patternmaker.

Steel Castings

Steel Castings Design and Manufacture. Foundry Trade Jl.; vol. 20, no. 199, July 1918, pp. 375-378. Discussion of paper presented before British Foundrymen's Assn., published in June issue.

The Manufacture of Steel Castings, E. F. Lange. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 372-374. Comparison of American with European standards and practice. (Sequel to Development in the Manufacture of Steel Castings, Feb. 1917.)

Vents

Venting Moulds and Cores, S. G. Smith. Foundry Trade Jl., vol. 20, no. 199, July 1918, pp. 367-371, 18 figs. Suggestions to apprentices on proper manner of providing passages for free escape of expanded air and gases.

See also Steel and Iron (Semi-Steel).

FUELS AND FIRING

Air Proportions

Calculating the Excess of Air Used in Combustion, V. Hassreidter. Gas Jl., vol. 143, no. 2881, July 30, 1918, p. 206. States that when volume, G, of producer gas is burned, volume of air required is not $R - G$, but $R - g + c - d$ where R is volume of products of combustion, c contraction and d expansion due to combustion. (Jl. Soc. Chem. Ind.)

Alcohol

Alcohol as Power Fuel. Gas & Oil Power, vol. 13, no. 155, Aug. 1, 1918, pp. 159-160. Account of research in production and adaptation of alcohol for power-fuel purposes carried out in Australia by a special committee under Commonwealth Advisory Council of Science and Industry.

Bituminous Coal

Burning Bituminous Coal in House-Heating Boilers, W. A. Pittsford. Heat. & Vent. Mag., vol. 15, no. 9, Sept. 1918, pp. 23-27, 15 figs. From address before Smoke Prevention Assn., Newark, Aug. 1918.

Method of Fixing Prices of Bituminous Coal Adopted by the United States Fuel Administration, C. Garnsey, R. V. Norris, and J. H. Allport. Bul. Am. Inst. Min. Engrs., no. 141, Sept. 1918, pp. 1411-1433, 6 figs. Discussion of four methods considered by Engineers' Committee: namely, actual cost at colliery plus fixed sum or percentage; actual cost at colliery plus graduated profit decreasing as costs increase; prices fixed on average cost in each district; all coal sold at average cost of district plus profit, and return to colliery adjusted through clearing house at price proportioned to cost of production.

Carbon Dioxide

Placing CO_2 on Financial Basis. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 62-64. Chart to estimate money lost up the stack due to low carbon dioxide, prepared for use of central-station engineers.

Coal Storage

Coal Storage in Large Quantities, Henry J. Edsall. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 193-200, 20 figs. Methods, equipment and typical installations, diagrams of arrangements of tracks and piles.

Handling Roundhouse Coal. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 372-375, 10 figs. Describes modern coal-handling system of belt conveyors for stocking and conveying coal to bins for locomotive and boiler-room use, installed at new Croxton roundhouse of Erie R. R.; capacity, 100 tons per hr.

Physical and Chemical Changes in Stored Coal. Gas Age, vol. 42, no. 6, Sept. 16, 1918, pp. 245-247, 5 figs. Results of tests. Translated from Revue Générale de l'Electricité.

Public Utility Experience in Coal Storage. Gas Age, vol. 42, no. 5, Sept. 2, 1918, pp. 193-196, 6 figs. Reports from various companies, secured by Univ. of Ill.

Reinforced Concrete Coal Storage Plant, H. C. Campbell. Eng. & Cement World, vol. 13, no. 5, Sept. 1, 1918, pp. 13-15, 5 figs. Description of pockets or storage bins especially designed for requirements, capacity and location.

Spontaneous Combustion of Stored Coal, S. H. Katz. Gas Age, vol. 42, no. 5, Sept. 2, 1918, p. 200. Results of experiments showing importance of proportion of voids in a mass of stored coal exposed to air. From Tech. Rep. 170, U. S. Bureau of Mines.

Storage and Handling of Gas Coal, H. H. Stoek. Gas Age, vol. 42, nos. 5 and 6, Sept. 2, and Sept. 16, 1918, pp. 207-210, 9 figs., and pp. 255-258, 10 figs. Review of investigations by Experiment Station of Univ. of Ill. Deals with locomotive crane storage; circular storage; steeple towers; Hunt System; bridge storage; swivel bridge; expense of storing.

The Storage of Bituminous Coal, John H. Anderson. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 321-322. Suggestions based on author's examination of piles on fire. Paper before Inst. of Marine Engrs.

Coal Valuations

An Alinement Chart for the Evaluation of Coal, A. F. Blake. La. Planter & Sugar Manufacturer, vol. 61, no. 10, Sept. 7, 1918, pp. 156-157. Designed to determine relative values of different coals, given price per ton and chemical analysis, by calculating the relative costs of a million heat units in accordance with the methods established by U. S. Bureau of Mines.

Combustion Losses

Combustion Losses and Their Minimization (III), Robert June. Brick & Clay Record, vol. 53, no. 6, Sept. 10, 1916, pp. 465-468, 2 figs. Heat losses in burning coal; in the dry chimney gases; due to incomplete combustion; in fuel through grate; due to superheating moisture in air and to moisture in fuel; due to visible smoke and to radiation.

Losses in the Boiler Room From Incomplete Combustion and High Stack Temperature, George H. Diman. Textile World Jl., vol. 54, no. 14, Oct. 5, 1918, pp. 82 and 87, 2 figs. Tables calculated from average conditions in New England textile mills.

Danish Fuels

Concerning Our (Danish) Fuels (Om vore Brændselsstoffer), Gunnur Jergensen. Ingenioren, vol. 27, no. 66, Aug. 17, 1918, pp. 454-459.

Fuel Changes

Problems Involved in Fuel Changes, A. Bement. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 380-382. Ash, not coal, the trouble maker; operatives do not change method of firing with coal. Some concrete instances and the remedies.

Fuel Conservation

Bulletin for Firemen and Engineers. Textile World Jl., vol. 54, no. 14, Oct. 5, 1918, pp. 81-82. Bul. no. 3 of Mass. Fuel Administration prepared by a committee of operating engineers and firemen.

Coal Conservation Committee. Final Report. Colliery Guardian, vol. 116, no. 3008, Aug. 23, 1918, pp. 385-388, 1 fig. Final report of committee appointed in 1916 by Mr. Asquith issued by Ministry of Reconstruction.

Coal Saving Suggestions and a Few Don'ts. Aera, vol. 7, no. 2, Sept. 1918, pp. 179-180, 1 fig. Suggestions based on experience of Westinghouse Elec. & Mfg. Co.'s combustion engineers.

Conservation of Fuel Used by Public Utilities, L. R. Nash, E. B. Powell and H. Vittinghoff. Stone & Webster Jl., vol. 23, no. 3, Sept. 1918, pp. 163-177. Considers loading and operation improvements for reducing fuel consumption to minimum by gas, electric light and power companies and railroads.

Fuel Saving in Massachusetts. Aera, vol. 7, no. 2, Sept. 1918, pp. 107-118. Method in vogue which, it is assured, will save 260,000 tons of coal during present year.

Practical Fuel Conservation, F. C. Wagner. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 401-404. Stationary engineer's part in campaign to conserve coal; suggestions regarding equipment and operation. Paper before Ind. State Convention, Nat. Assn. Stationary Engrs.

Report of Coal Conservation Committee. Engineer, vol. 126, no. 3269, Aug. 23, 1918, p. 158, 2 maps.

Fuel Supplies

Is Our Fuel Supply Nearing Exhaustion? R. H. Fernald. Ry. Rev., vol. 63, no. 8, Aug 24, 1918, pp. 271-275. Digest of fuel resources of the world and particularly of United States, giving statistical data as to rates of production, rates of depletion, and prospects of exhaustion. From Gen. Elec. Rev.

Furnaces

Combustion and Smokeless Furnaces, Joseph W. Hays. Steam, vol. 22, no. 3, Sept. 1918, pp. 65-70. Discussion based on nature and properties of heat and on Berthelot's Second Law regarding heat produced in a furnace. (To be continued.)

Gas Firing

Gas Firing for Boilers, T. M. Hunter. Elec. Times, vol. 54, no. 1398, Aug. 1, 1918, pp. 73-74. Remarks on advisability of firing boilers with gas. Paper before South Wales Inst. of Engrs.

Low-Grade Fuels

Experience with the Combustion of Lignites, R. A. Ross. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 208-210. Experiments at Saskatoon plant.

Method for the Combustion of Brown Coal. Marine Eng. of Can., vol. 8, no. 9, Sept. 1918, p. 241. Brief note on process based on applying conditions in water-gas producer to boiler furnace and using exhaust steam for gas production.

Suggestions for Efficiently Burning Lignites in a Domestic Furnace, R. G. McLaurin. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 210-213, 1 fig. Prerequisites for efficient combustion of western coal are new furnace design, and control of combustible and air.

The Use of Lignite, Bagasse and Wood Waste for Power Generation and Other Purposes, John B. C. Kershaw. Engineer, vol. 126, no. 3268, Aug. 16, 1918, pp. 133-134. (Second article.)

Low-Rate Combustion

Getting Fuel Economy Under Difficulty. Black Diamond, vol. 61, no. 13, Sept. 28, 1918, p. 249. Suggestions to save coal while under low-rate combustion in hand-fired plants. From Tech. Paper No. 139, Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces, Bureau of Mines.

New England

The Fuel Situation in New England, Charles T. Main. Power, vol. 48, no. 14, Oct. 1, 1918, p. 508. From paper before New England Water Works Convention, Sept. 1918.

Oil Storage

Losses of Oil in Storage, C. P. Bowie. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 235-237. Data of losses by evaporator and from wooden and steel rod tanks; devices for lessening losses. From Oil Storage Tanks and Reservoirs, Bul. 155 (Petroleum Technology 41) of the Bureau of Mines.

Peat

Coal Conservation, Gas Producer Economics. Gas & Oil Power, vol. 13, no. 156, Sept. 5, 1918, pp. 167-168. Utilization of peat fuels in production of gas for suction engines.

The Value of Peat Fuel for the Generation of Steam. Engineer, vol. 126, nos. 3269 and 3270, Aug. 23 and Aug. 30, 1918, pp. 163-166, 6 figs, and pp. 178-180, 4 figs.

The Utilization of the Peat Resources of Canada, B. F. Haanel. Jl. Soc. Chem. Industry, vol. 37, no. 15, Aug. 15, 1918, pp. 258T-261T. Canadian peat deposits; description of peat; cost of manufacture; utilization for industrial purposes; peat as a source of oil and retort gas.

Pulverized Coal

A Diversified Application of Powdered Coal, Charles Longnecker. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 619-623, 8 figs. Pulverized fuel, distributed by compressed air to substations, used in open-hearth, annealing and other furnaces.

Fuels, E. R. Knowles. Steam, vol. 22, no. 3, Sept. 1918, p. 76. Four requirements in burning of pulverized coal and attainable with it. (Concluded from August issue.)

Powdered Coal Cuts Coal Consumption in Annealing Ovens Thirty Per Cent. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 300, 1 fig. Brief account of recent work done at malleable-iron plant of Am. Radiator Co., Buffalo.

Pulverized Coal Firing. Iron & Coal Trades Rev., vol. 97, no. 2636, Sept. 6, 1918, p. 265, 1 fig. Particulars of system developed by Fuller Engineering Co.

The Possibilities of Powdered Coal as Shown by Its Combustion Characteristics, W. G. Wilcox. Steam, vol. 22, no. 3, Sept. 1918, pp. 70-75. Requirements necessary in perfect combustion, weaknesses of present methods; conclusions regarding powdered coal. Paper before N. Y. Section, Am. Chem. Soc.

Soft Coal

Burning Soft Coal in Heaters Designed for Hard Coal. Heat. & Vent. Mag., vol. 15, no. 9, Sept. 1918, pp. 21-23. Suggestions for selecting and using coal for house-heating equipment.

Stokers

Handling Jones Under-Feed Stokers, "Receiver." Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 743-744, 4 figs. Building and banking fires; precautions to observe in handling fires.

Smokeless Combustion with Chain-Grate Stokers, Thomas A. Marsh. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 448-449, 2 figs. Discussion of furnace chambers, boiler settings and baffling as affecting efficiency and smokeless combustion of high-volatile coals. Paper before Annual Smoke Prevention Convention, Newark, N. J.

The Stoker of the Future, Joseph Harrington. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 442-443. Analysis of mechanical-stoker evolution as influenced by coal characteristics, clinker, efficiency and rate of combustion.

Wood

Wood Fuel, A. Barbey. Domestic Eng., no. 277, Sept. 1918, pp. 1-3. Present situation in Switzerland. Paper before Vaudoise Soc. of Nat. Sci. From Bulletin Technique.

See also Forging (Fuel); Coal Industry (Fuel Conservation); Hoisting and Conveying (Coal Handling); Mines and Mining (Shale Oil); Motor-Car Engineering (Fuels).

FURNACES

Electric Brass Furnace

A Rocking Electric Brass Furnace, H. W. Gillett and A. E. Rhoads. Brass World, vol. 14, no. 9, Sept. 1918, pp. 264-268. Description of furnace at plant of Michigan Smelting & Refining Co., with results of tests and bibliography of electric-furnace literature.

Gas Heat-Treating Furnace

Automatic Shell Heat Treating Furnaces, W. J. Harris, Jr., Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 565-568, 8 figs. Human element superseded by mechanical devices in a new gas-fired installation at Pawtucket.

Induction Furnaces

Production of High Temperature and Its Measurement, E. F. Northrup. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 212-221, 6 figs. Principle of operation and details of a 20-kw. electric induction simple crucible furnace.

Nitrogen-Fixation Furnaces

Nitrogen Fixation Furnaces, E. Kilburn Scott. Gen. Meeting Am. Electrochem. Soc., Oct. 2, 1918. Advanced Copy, Paper 8, pp. 103-134, 17 figs. Review and comparison of various types of electrical furnaces; description of author's three-phase furnace and discussion of its details in comparison with other types.

Resistance Furnaces

Tests on a Resistance Electric Furnace for High Temperatures (Försök med en elektrisk motstandsugn för höga temperaturer), Jakob Forssell. Teknisk Tidskrift,

vol. 48, no. 66, July 24, 1918, pp. 93-98, 4 figs.

HEATING AND VENTILATION

Electric Heating Units

Electricity as a Substitute for Gas, Frank Thornton. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 324-325. Comparison of electricity as heating unit with natural gas and coal; conditions which have developed electrical heating. From paper before Engrs.' Soc. of Western Pa. (To be Continued.)

Equipment

Care of Heating and Ventilating Equipment, Harold L. Alt. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 383-384. First of series on economical operation.

Factories

Difficult Problems of Paper Manufacturers Solved by the Sturtevant Absorption System. Paper Mill, vol. 41, no. 40, Oct. 5, 1918, pp. 16 and 44-46, 3 figs. Heating and ventilating system of large mill.

Factory Heating. Chas. L. Hubbard. Steam, vol. 22, no. 3, Sept. 1918, pp. 63-65. Methods of computing available exhaust-and live-steam requirements. (To be continued.)

Heating and Ventilating Are Very Important (II). M. H. Potter. Can. Machy., vol. 20, no. 8, Aug. 22, 1918, pp. 225-227, 6 figs. Systems of heating buildings; machine-shop arrangements; suitable temperatures; artificial lighting.

Heating Systems

Fuel Saving Heating Systems, Alfred G. King. Domestic Eng., vol. 84, no. 8, pp. 272-274, 5 figs. How the vapor-vacuum system is installed; how it operates and how fuel is conserved.

Heating and Piping Systems. Contract Rec., vol. 32, no. 37, Sept. 11, 1918, p. 740. Points to be considered in design of a heating system.

Pressure Regulation

Pressure Regulating Devices, Chas. L. Hubbard. Domestic Eng., vol. 84, no. 9, Aug. 31, 1918, pp. 312-314, 7 figs. Notes on construction and operation of pressure-reducing valves for modern heating systems. (To be continued.)

School Buildings

School Building Heating and Ventilation, Samuel R. Lewis. Heat. & Vent. Mag., vol. 15, no. 9, Sept. 1918, pp. 33-43, 14 figs. Second article.

Turbo-Generator Ventilation

The Ventilation of Turbo-Generators, J. Humphrey. Iron & Coal Trades Rev., vol. 97, no. 2636, Sept. 6, 1918, pp. 260-261, 1 fig. Deal chiefly with question of dust removal from air.

See also Fuels and Firing (Low-Grade Fuels).

HOISTING AND CONVEYING

Chains

Safe Chain Loads, A. Black. Machy., vol. 25, no. 1, Sept. 1918, pp. 37-39. Factors that determine safe loads and effects obtained by annealing chains.

The Manufacture and Testing of Cast Steel Chain Cables. Page's Eng. Weekly, vol. 33, no. 728, 1918, pp. 88-90. Memorandum issued by Lloyd's register of shipping.

Coal Handling

A New Design for Engine Coaling Facilities. Ry. Age, vol. 65, no. 14, Oct. 4, 1918, pp. 615-616. 2 figs. Economies effected in track capacity and car supply on Erie R. R.

Coal and Shipping. Transport from Collieries to Ports, F. J. Warden-Stevens. Colliery Guardian, vol. 116, no. 3009, Aug. 30, 1918, pp. 439-440. Description of means and equipment for shipping coal from mines to ports in the United Kingdom.

Concrete Coal Bins Prove Profitable, C. W. Hull. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 23-24, 2 figs. Record of successful operation and methods of unloading from cars and loading trucks.

Coal Tipples

Simpson Creek Coal Company's Tipples, R. G. Read. Coal Age, vol. 14, no. 11, Sept. 5, 1918, pp. 430-433, 5 figs. Features of design described and illustrated.

Conveyors

Conveyor at the Wellpark Brewery, Glasgow. G. F. Zimmer. Engineering, vol. 106, no. 2746, Aug. 16, 1918, pp. 165-168, 15 figs. Illustrated description of a combination push-bar or drag-link conveyor and the roller runway.

Conveyors for Chemical Works, William H. Atherton. Conveying (Supp. to Cassier's Eng. Monthly), vol. 1, no. 4, Sept. 1918, pp. xxix-xxxiv, 9 figs. General arrangement of plant for handling granulated niter cake. (Continuation of serial.)

Conveyors, Robert S. Lewis. Min. & Sci. Press, vol. 117, no. 11, Sept. 14, 1918, pp. 349-355, 8 figs. Data for designing and calculating belt-conveyor systems.

Portable Automatic Trimming Conveyor, Geo. F. Zimmer. Conveying (Supp. to Cassier's Eng. Monthly), vol. 1, no. 4, Sept. 1918, pp. xxxv-xi, 6 figs. Device to handle coal with minimum expenditure of manual labor to trim it uniformly over the available bunker space provided in naval, mail and cargo steamers.

Cranes

Industrial Controllers (XXI). H. D James. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 368-371, 12 figs. Electrical operation of cranes; diagrams of connections; design features of various types.

Elevators

Development of V-Groove Elevator, Charles Reedy. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 410-413. History of experiments; discussion of various makes of traction drives; features of operating costs and details. Abstract of paper before convention of Elevator Mfrs.' Assn.

Mine Locomotives

A New Type of Mine Locomotive Controller, L. W. Webb. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 620-622, 8 figs. Pneumatic hand-operated control for electric power equipments.

Ore Cars

Ore Car Designed at Hecla Mine, C. T. Rice. Eng. & Min. Jl., vol. 106, no. 12, Sept. 21, 1918, pp. 522-525, 4 figs. Detailed description of a car having a capacity of 82 cu. ft., to be let down a shaft 4 by 5 ft. and pass around a 28-ft. curve on a 24-in. track.

Safety Appliances

Safety in Winding Operations (II). J. A. Vaughan. South African Jl. & Eng. Rec., vol. 27, nos. 1400 and 1401, July 27, and Aug. 3, 1918, p. 318 and pp 296-297. July 27: Discussion of several faults or omissions of winding engine drivers, suggestions to prevent them. Aug. 3: Considerations on movement of reversing levers and automatic application of brakes. Before S. A. A. A. S. (Continuation of serial.)

Winding Mechanism

Automatic Cable Winding Mechanism, Donald A. Baker. Machy., vol. 25, no. 1, Sept. 1918, pp. 44-45, 3 figs. Arrangement for winding cable used for making lead balls for shrapnel shells.

Wire Ropes

The Factor of Safety of Wire Ropes (II). South African Mining Jl., vol. 27, part 2, no. 1394, June 15, 1918, pp. 171-172. Author's reply to criticisms of his previous discussion, offered by other members of the Inst. Paper before S. A. I. of E.

See also Railroad Engineering, Steam (Cranes); Safety Engineering (Winding Engines).

HYDRAULICS

Dams

Calaveras Dam Slide—Report on Failure of Hydraulic Fill Dam During Construction, D. C. Henny and C. H. Swigart. Reclamation Rec., vol. 9, no. 9, Sept. 1918, pp. 433-435, 2 figs. Report of investigation ordered by chief of construction, U. S. Reclamation Service, giving original construction, tests of materials and subsequent design amendments.

Method of Keying Sections of Concrete Dam, Frank P. Fifer. Can. Engr., vol. 35, no. 9, Aug. 29, 1918, p. 210, 1 fig. Method employed in construction of lock and dam on Hudson River at Troy, N. Y.

Sixty-One-Foot Hydraulic-Fill Dam Rests on Earth Foundation. William G. Fargo. Eng. News-Rec., vol. 81, no. 11, Sept. 12, 1918, pp. 491-495, 9 figs. Junction hydroelectric development in southern Michigan notable for winter placing of earth fill and for extreme height of concrete retaining walls, which hold 90 ft. of fill.

Weighing Materials Saved Cement on Three Big Dams, H. H. Hunt. Contract Record, vol. 32, no. 37, Sept. 11, 1918, pp. 738-740. How concrete proportioned by weighing the cement, sand and gravel reduced the volume of cement used on three hydroelectric developments completed recently in Michigan and Minnesota.

Hydroelectric Plants

New Hydroelectric Plant of Montana Power Company, W. A. Scott. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, pp. 18-22, 2 figs. Details of hydraulic equipment of project adding 48,000 kva. to system.

Mysore Irrigation Project

A Great Mysore Irrigation Project. The Waste Weir of the Krishnarajasagara, B. Bubba Rao. Indian & Eastern Engr., vol. 42, no. 5, May 1918, pp. 157-158, 2 figs. Program for completing war work; protection works; calculations for stability of waste weir section. Paper before Mysore Engrs.' Assn. (Continued from preceding issue.)

Tasmania Hydroelectric Development

The Great Lake Hydro-Electric Development of Tasmania, Ludwig W. Schmidt. Power, vol. 48, no. 10, Sept. 3, 1918, pp. 328-330, 7 figs. Description of some features of a 100,000-hp. hydroelectric development undertaken by private enterprise and completed with financial aid of government of Tasmania.

Water Power

Water Power Development to Conserve Coal. Ry. Rev., vol. 63, no. 8, Aug. 24, 1918, pp. 268-270. Outline of legislation proposed by administration to conserve country's fuel supply and man power through resort to hydroelectric development on an extensive scale for railway purposes.

Water Power in Industry: Its Place and Value A. Newlands. Ry. News, vol. 110, no. 2854, Sept. 14, 1918, pp. 195-196. Estimated extent to which water power has been utilized the world over. (British Science Guild.)

Water Works

War Burdens of Water-Works in the United States. Am. City, vol. 19, no. 3, Sept. 1918, pp. 193-194. Summary of findings and conclusions of Executive Committee of Am. Water Works Assn.

Water Works Operation. Mun. Jl., vol. 45, no. 9, Aug. 31, 1918, pp. 170-171, 1 fig. Selection of service pipe—galvanized lead, lead-lined and cement-lined.

See also Air Machinery (Air Compressors); Sanitary Engineering (Water Supply).

INDUSTRIAL ORGANIZATION

Depreciation

Depreciation and Rate Making, L. R. Nash. Elec. Ry. Jl., vol. 52, no. 12, Sept. 21, 1918, pp. 511-513. States that use of an undepreciated value with sinking-fund accruals for depreciation is not only justified by precedent and correct accounting principles but is desirable on ground of public policy.

Industrial Census

What an Industrial Census Can Do, Dale Wolf. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 213-216. Results of an experiment of Miller Lock Co.

Industrial Organization

New Developments in Industrial Organization, W. G. Cass. Cassier's Eng. Monthly, vol. 54, no. 3, Sept. 1918, pp. 131-142. Methods followed at Port Sunlight Works. (To be continued.)

See also Marine Engineering (Industrial Management); Railroad Engineering, Steam (Salvage).

INTERNAL-COMBUSTION ENGINEERING

Alcohol Engines

Power-Alcohol and Alcohol Engines. Automobile Engr., vol. 8, no. 116, July 1918, pp. 188-189. Notes on report of Committee of Advisory Council of Science and Industry of Australia.

Diesel Engines

Coal Tar Oil for Diesel Engines, A. W. H. Griepe. Gas Eng., vol. 20, no. 10, Oct. 1918, pp. 465-473, 11 figs. Physical and chemical characteristics of suitable coal-tar oils.

Conserving Our Natural Resources by the More Extended Use of the Diesel Engine, P. L. Scott. Sibley Jl. of Eng., vol. 32, no. 12, Sept. 1918, pp. 178-180. Shows position author believes Diesel and surface-ignition engines will occupy in conservation of

present source and in use of fuels not yet widely recognized. From The Pacific Marine Review. (First of a series of six articles.)

Gas Turbines

The Gas Turbine, Georges Funck. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 249-254, 20 figs. Two possible methods of operation of a steam turbine; illustrations of two proposed methods for gas turbine: combustion of mixture at constant pressure, and at constant volume. Efficiency obtainable in gas turbine. Paper before Graduates' Section, Instn. Automobile Engrs.

High-Speed Engines

High-Speed Internal Combustion Engines, H. R. Ricardo. Mech. World, vol. 64, no. 1648, Aug. 2, 1918, p. 57. Range of mixture strength available with petrol; volumetric efficiency. Paper before Northeast Coast Instn. of Engrs. & Shipbuilders. (Continuation of serial.) Also published in Automobile Engr., vol. 8, no. 116, July 1918, pp. 184-188, 18 figs.

Low-Compression Oil Engines

Some Features of Low-Compression Oil Engines, L. H. Morrison. Power, vol. 48, no. 13, Sept. 24, 1918, pp. 455-458, 8 figs. Several forms of fuel injection pumps and nozzles described and information given concerning their care and repair. (Fifth article.)

Offset Cylinders

Offset Cylinders, A. Johnson. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 244-245, 3 figs. Mathematical investigation of désaxé setting.

Rotary Engines

Augustine Rotary Two-Cycle Super-Induction Gas Engine. Gas Eng., vol. 20, no. 10, Oct. 1918, pp. 481-487, 14 figs. Description with drawings of new design of rotary air-cooled engine developed by Augustine Automatic Rotary Engine Co., Buffalo, N. Y.

Thermodynamic Cycles

Thermodynamic Cycles in Internal Combustion Engines, Wm. J. Walker. Aerial Age, vol. 8, no. 3, Sept. 30, 1918, pp. 126-127, 12 figs. Discussion of increasing power of engine by increasing m.e.p. of cycle.

Tractor Engines

Oil Burning Tractor Engines, H. H. Sward. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 209-210, and discussion 210-211. Considerations regarding fuel selection.

See also Aeronautics (Engines).

LABOR

Contract System

Labor Shortage Made Good by Station Contract System, F. P. Kemon. Eng. News-Rec., vol. 81, no. 12, Sept. 19, 1918, pp. 542-544, 4 figs. How Winnipeg aqueduct workers speeded completion of work at contract prices which netted 30 to 40 per cent increase in wages.

Cooperative Plants

Philadelphia Coöperative Plan Extended. Elec. Ry. Jl., vol. 52, no. 11, Sept. 14, 1918, pp. 459-462. Success of the plan for producing cordial relations between labor and capital demonstrated by eight years of experience; wages now raised to equal of the highest established by War Labor Board; several changes in original plan.

Solving Labor Relationship Problems. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 320-322. Account of work done by directors of a company who have asked their employees to coöperate with them and to help decide what their mutual relation should be. (To be continued.)

Cost of Living

How to Determine Cost of Living in an Industrial Community, Ray M. Hudson. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 185-192. Gives in complete detail results and basis of a cost study made for the H. H. Franklin Mfg. Co.

Cripples

Rehabilitating Cripples at Ford Plant, J. E. Mead. Iron Age, vol. 102, no. 13, Sept. 26, 1918, pp. 739-742, 8 figs. Full efficiency obtained by 85 per cent; light handwork in hospital speeds recovery.

Employee Representation

Midvale Plan of Employee Representation. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 834-835. Delegate for each 300; about one-tenth of these form plant committee; general committee for all plants; arbitration provided for if necessary.

Housing

Engineering Possibilities of Circular Housing Plan, G. J. Lamb. Can. Engr., vol. 35, no. 9, Aug. 29, 1918, pp. 193-196, 3 figs. Layout of block of 21 houses; particulars of water mains, sewers and maintenance.

Labor Plans

Beginnings of Labor Maintenance Service in a Small Plant, Mary L. Morris. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 205-208, 3 figs. How this work was started in a textile mill employing 500 workers; work divided into medical, employment and social divisions.

Conservation of Our Human Equipment, Earl B. Morgan. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 316-318. Methods of selecting men for job; organizing methods for, taking care of workmen; how to conduct investigations; centralizing control of shop activities. (Concluded from June issue.)

How a Medium-Sized Plant Solves Its Labor Problems, H. E. Sloan. Machy., vol. 25, no. 1, Sept. 1918, pp. 11. Proper working conditions; hourly wages and bonus payments; American citizenship desirable.

Mine Labor

The Coal Shortage, F. W. Gray. Can. Min. Jl., vol. 39, no. 17, Sept. 1, 1918, pp. 291-293. True aspects of situation as seen by writer who suggests return of enlisted miners.

Training

Experience in Training Mechanical Operators. Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 551-553, 8 figs. Machine-tool plant of medium size succeeds in effort to develop efficient workers from unskilled men and women.

How to Start Training in a Factory, Frank L. Glynn. Am. Industry, vol. 19, no. 2, Sept. 1918, pp. 22-25, 4 figs. Plan developed in Curtiss Aeroplane Co., Buffalo, and suggestions to manufacturers.

Industrial Training—A War Measure, C. S. Coler. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 352-353, 4 figs. Vestibule school of Westinghouse Elec. and Mfg. Co.

Training Men and Boys in a Shop School, A. N. Hook. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 567-569. Successful methods of graduating a large number of workmen and at the same time lessening the financial burden of the school's maintenance.

Training School at Hog Island, W. H. Blood. Stone & Webster Jl., vol. 23, no. 3, Sept. 1918, pp. 178-181, 9 figs. System followed and results being obtained.

Turnover

Computing Labor Turnover. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 239-246. Results of a questionnaire to determine definition of labor turnover and how it is computed in various plants.

Wages

Living Costs and Wage Standardization, W. B. Wilson. Aera, vol. 7, no. 2, Sept. 1918, pp. 145-146. Secretary of Labor in New York address says differences as between communities may have to be disregarded and uniform rates provided for entire country.

New Wage Increase. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 335-339. Text of two supplements stabilizing wages and removing inequalities occurring in general order No. 27, United States Railroad Administration.

Women Workers

The Employment of Women in Munition Factories, O. E. Monkhouse. Jl. Instn. Mech. Engrs., no. 4, April 1918, pp. 213-221. Unskilled types of women educated, domestic, ordinary; training of women; how they have reached their present skill; hours of work.

Training the Woman War Worker, Edward K. Hammond. Machy., vol. 25, no. 1, Sept. 1918, pp. 15-17, 3 figs. Methods used in the plant of Taft-Pierce Company, Woonsocket, R. I., in training of women machine operators by means of a "vestibule" school.

Women on Kansas City Railways, J. E. Gibson. Aera, vol. 7, no. 2, Sept. 1918, pp. 93-102, 6 figs. What has been done to make their employment attractive and to secure the best class.

Women Substation Operators a Notable Success. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 545-548, 6 figs. Pioneer work of Boston Edison Co. in training women for electrical service; synopsis of course of instruction.

See also Foundry (Man Power); Marine Engineering (Man Power); Mines and Mining (Man Power).

LIGHTING

Daylight, Artificial

Artificial Daylight in the Industries, M. Luckiesh. Elec. World, vol. 72, no. 13, Sept. 28, 1918, pp. 596-598. Qualifications of light required for color discrimination, with examples of industrial use of daylight lamps installed in many varied establishments.

Factory Lighting

Laws Relating to Factory Lighting, W. T. Blackwell. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 312-313. Discussion on proper application of light in shops.

Some Important Phases of Industrial Lighting, W. T. Blackwell. Elec. Rev., vol. 73, no. 10, Sept. 7, 1918, pp. 360-362, 3 figs. Conservation of labor through improved lighting; proper lighting layout a simple problem; typical example; commonly neglected features of factory lighting.

Lighting Methods

The Lighting Art; Its Practice and Possibilities in Interiors. M. Luckiesh. Trans. Illuminating Eng. Soc., vol. 13, no. 6, Aug. 30, 1918, p. 354. Abstract of paper before Chicago Section of society.

Selection of Lighting Units, Davis H. Tuck. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 552-554, 5 figs. Simple method of analyzing distribution curves explained; efficiency of reflectors.

Paint Works

Improvement of Lighting of Paint and Varnish Works, F. H. Bernhard. Elec. Rev., vol. 73, no. 13, Sept. 28, 1918, pp. 481-486, 6 figs. Seventh article on improvement of lighting in the industries.

Woodworking Plants

Need of Improved Lighting of Woodworking Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 11, Sept. 14, 1918, pp. 401-408, 8 figs. Sixth of series of articles on lighting in the industries. Present article shows how better lighting speeds up production, improves quality and reduces accidents; low cost; common faults; some suggestions for betterment.

See also Electrical Engineering (Lighting); Municipal Engineering (Street Lighting); Railroad Engineering, Steam (Car Lighting).

LUBRICATION

Dredges and Shovels

Lubrication of Steam Shovels and Dredges. Eng. & Cement World, vol. 13, no. 5, Sept. 1, 1918, p. 74. Recommendation made by the Texas Co.

Lubricating Oils

Lubrication and Lubricating Oils, N. C. Brunn. Ry. Gaz., vol. 29, no. 8, Aug. 23, 1918, pp. 205-206. Abstract of results obtained on neutral, animal and vegetable oils. From paper before Soc. of Engrs., Tokio.

Viscosity

Relation Between Viscosity and the Chemical Constitution of Lubricating Oils, A. E. Dunstan and F. B. Thole. Jl. Instn. Petroleum Technologists, vol. 4, no. 16, June, 1918, pp. 191-216, 5 figs., and (discussion) pp. 216-229. Theoretical discussion on measurement of absolute viscosity; review of experimental data on American, Russian and Scotch oils, obtained by various authors; condensed bibliography.

See also Air Machinery (Air Compressors); Machine Shop (Oil Reclamation); Marine Engineering (Oil Coolers).

MACHINE DESIGN

Nomography

Nomography in Engine Design, F. Leigh Martineau. Jl. Soc. Automotive Engrs., vol. 3, no. 3, Sept. 1918, pp. 224-234, 23 figs. Practical study of graphic representation of formulæ and construction of various diagrams. Paper before Instn. Automotive Engrs., London.

MACHINE PARTS

Bearings

Ball Bearings for Machine Shop Equipment, Edward K. Hammond. Machy., vol. 25, no. 1, Sept. 1918, pp. 50-58, 22 figs. Second of a series.

Refitting Engine Bearings, C. H. Willey. Mech. World, vol. 64, no. 1648, Aug. 2, 1918,

pp. 56-57, 6 figs. Oil-flood method to locate knocks that develop during a run on a peak load; rebabbitting bearings. From National Engineer. (To be continued).

Using Ball Bearings in Marine Machinery. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 322-323, 6 figs. Work done in Sweden; progress made in Canada.

Belts

Belting Problems Discussed at Chicago Meeting. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 56-60. Account of meeting of belt manufacturers, sales representatives and engineers at which data concerning belt performance in varied industrial plants were presented.

Bolts

Big End Bolts. Gas & Oil Power, vol. 13, no. 156, Sept. 5, 1918, pp. 173-174, 1 fig. Discussion of their fracture and failure.

Pulleys

Saving Coal by Efficient Pulleys, Charles H. Machen. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 536-538, 4 figs.

Springs

Helical Springs, M. H. Sabine. Mech. World, vol. 64, no. 1648, Aug. 2, 1918, p. 55, 6 figs. Layout and formulæ to determine number of coils and free length.

See also Aeronautics (Bolts); Forging (Piston Rods).

MACHINE SHOP

Balancing

Methods of Balancing Rotors, C. C. Brinton. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 349-352, 9 figs. Static and dynamic balancing systems and machines.

Bulldozer Operations

Bulldozer Operations with One and Two-Motion Dies, J. V. Hunter. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 465-470, 20 figs. A variety of work that can be done in a bulldozer with properly designed dies.

Case-Hardening Materials

Case Hardening, S. S. Amdursky. Gas Industry, vol. 18, no. 8, Aug. 1918, pp. 259-261, 3 figs. Result of investigations by a gas and electric company into possibilities of converting both coal and oil-fired case-hardening furnaces to use gas.

Testing the Relative Merits of Case-Hardening Materials, Clarence N. Underwood. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 569-571, 3 figs. Method consists in case-hardening test pieces with various materials to be tested and in measuring the results.

Cutting Metals

The Cutting of Iron and Steel by Oxygen (XVIII), M. R. Amadeo (Translated from original French by D. Richardson). Acetylene & Welding Jl., vol. 15, no. 179, Aug. 1918, pp. 140-141, 1 fig. Peculiarities of carburized metal found in cuts made with central-jet blowpipes; formation of heating flame.

Gage Making

Elements of Gage Making, C. A. Macready. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 511-519, 21 figs. Amount and trend of distortion due to heating by grinding wheels. Fourth of series.

Heat Treatment

Correct Heat Treatment of Die Blocks, G. Peterson. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 295-297, 1 fig. Theory of crystallization and influence of mass in relation to temperature; bearing of these theories on subject.

Heat-Treating Gears for Army Trucks in the Electric Furnace. Dwight D. Miller. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, p. 461, 1 fig. Benefits derived from proper heat treatment of gears; use of electric furnace for heat treatment of gears; use of electric furnace for heat treatment.

Using Electrical Furnaces for Annealing, Wirt S. Scott. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, p. 323. Control equipment used; conditions for which furnace is adapted. (Concluded from June issue.)

Milling

Milling Practice in Railway Shops, Frank A. Stanley. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 521-524, 9 figs. Examples of cutters used with success in Southern Pacific Shops in Sacramento, Cal.

Navy Repairs

War-Time Repairs in the Navy, Frank A. Stanley. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 621-624, 12 figs. Describes a miscellaneous line of work and special cutters, hobs and other tools. Fourth article.

Oil Reclamation

Reclaiming Oil from Metal Turnings, C. L. Smith. Iron Age, vol. 102, no. 10, Sept. 5, 1918, pp. 558-559, 3 figs. Scheme employed by Cincinnati Milling Machine Co. makes use of a special collecting truck and a separator set flush with floor.

Plating

Effecting War Economies in the Plating Room, E. P. Later. Foundry, vol. 46, no. 10, Oct. 1918, pp. 461-463. How waste may be eliminated and metals, acids and other materials conserved by exercising greater care in operation.

Radiator Manufacture

The Manufacture of the Sperry-Type Automobile Radiator. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 522-524, 8 figs. Description of the sheet-metal work in making this type of radiator.

Welding

The Autogenous Welding of Lead (III), P. Rosenberg. Acetylene & Welding Jl., vol. 15, no. 179, Aug. 1918, pp. 134-135, 8 figs. Hydrogen and oxy-acetylene installations.

Electric Arc Welding. Domestic Eng., no. 277, Sept. 1918, p. 5. Formula to calculate approximate heat quantities involved in welding. Paper before Cleveland Eng. Soc.

Fusion Welding Fallacies, S. W. Miller. Machy., vol. 25, no. 1, Sept. 1918, pp. 12-13, 5 figs. Third of a series.

Selection and Application of Electric Arc Welding Apparatus, A. M. Candy. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 337-346, 25 figs. Chief requisites for electric arc welding both with alternating and direct current; constant-current vs. constant-potential generators; protective equipment and accessories; selection of electrodes; gas vs. arc.

Wheel Hubs

Machining Front Wheel Hubs, A. Thomas. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 264-266, 12 figs. Operations in manufacturing front-wheel hub from drop forging of 3 per cent nickel steel.

See also Air Machinery (Compressed-Air Applications); Marine Engineering (Welded Ships); Mechanics (Balancing); Millwrighting; Safety Engineering (Machinery Movements).

MACHINE TOOLS

Dies

Construction and Operation of Temporary Dies, Hugo F. Pusep. Am. Machy., vol. 49, no. 11, Sept. 12, 1918, pp. 488-489, 6 figs. Method outlined shows how dies can be built for small output at little expense.

Double-Movement Dies for Bulldozer Work, J. V. Hunter. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 508-510, 9 figs. Illustrations of cheaply made double-movement dies for use in a bulldozer.

Presses

Dies for Tape-Measure Winder. Machy., vol. 25, no. 1, Sept. 1918, pp. 46-48, 6 figs. Set of dies for performing sequence of operations under power press.

Mechanical Presses, Métaux, Alliages et Machines, year 11, no. 7, July 1918, pp. 10-13, 9 figs. Their utilization after the war. (Concluded from May issue.)

Wright Dieing Machine. Machy., vol. 25, no. 1, Sept. 1918, pp. 73-75, 3 figs. Machine adapted for performance of those classes of operations usually handled in dies operated by power presses.

See also Metal-Working Tools.

MACHINERY, SPECIAL

Hosiery Machinery

Drilling Jigs Used in the Manufacture of Hosiery Machines, Robert Mawson. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 563-565, 10 figs. Many of the jigs described are simple in design but produce as equally accurate results as more complicated tools.

Sand-Blast Machinery

Automatic Positive Pressure Sand Blast Apparatus. Compressed Air Mag., vol. 23, no. 9, Sept. 1918, pp. 8884-8886, 1 fig. Machine controlled by specially designed manifold valve.

MARINE ENGINEERING

Barges

Upper Mississippi River Barge Fleet, B. L. Brown. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 199-202. Data on construction and equipment of 19 steel barges, with double bottoms and four towing steamers, designed to handle up-stream tonnage against rapid currents.

Cargo Steamers

The Most Suitable Sizes and Speeds for General Cargo Steamers, John Anderson. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 505-511, 13 figs. Method of determining most economical dimensions of cargo vessels for any length of voyage, condition of loading and speed. Paper before Instn. of Naval Architects, London, March 1918.

Concrete Ships

Concrete Barge Specifications Show Many Unusual Features. Marine News, vol. 5, no. 3, Aug. 1918, pp. 70-71 and 122. Details of 21 vessels to be used on New York state barge canal system.

Concrete Ships, Harvey S. Owen. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 243-255. Concrete ship designing problems; light aggregate and protective coating recently developed; opinions regarding durability of concrete ships.

Construction Features of Concrete Ships. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 303-304. The concrete; reinforcing steel; mixing and placing concrete; durability of a concrete ship. Abstract of paper by Rudolph J. Wig and S. C. Hollister before Amer. Concrete Inst.

Construction of Concrete Ships for Emergency Fleet Corporation, R. J. Wig. Can. Engr., vol. 35, no. 9, Aug. 29, 1918, pp. 212 and 214. Principal characteristics of 3500-ton concrete ship. From special report to U. S. Shipping Board.

Developments in Concrete Barges and Ships, J. E. Freeman. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 520-522. Brief résumé of history of concrete shipbuilding; what has been accomplished in United States and abroad. From paper before Am. Concrete Inst., June 1918.

Ferro-Concrete Ships. Ferro-Concrete, vol. 10, no. 1, July 1918, pp. 7-17. Discussion of paper by T. J. Gueritte before North-East Coast Instn. of Engrs. & Shipbuilders, published in Apr. issue.

Method of Concrete Ship Construction, Theodore Ahlborn. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 517-520, 6 figs. Reinforcing diagrams of parts of the hull; methods of construction.

Reinforced Concrete Vessels, Walter Pollock. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 512-517, 9 figs. Discussion of factors involved in designing small coastwise concrete motorship. From paper before Instn. of Naval Architects, London, March 1918.

Eagles

Manufacturing Eagles at Ford Shipyard, Chas. Lundberg. Iron Age, vol. 102, no. 12, Sept. 19, 1918, pp. 679-684, 13 figs. Submarine chasers assembled on wheels and dropped into water; a launching a day the aim; general description of operation and plant.

Electrical Machinery

Electrical Applications to Merchant Vessels, H. A. Hornor. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 490-503. General methods of installation in present practice; distribution, generating sets, switchboards, lighting fixtures, searchlights and interior communication.

Fabricated Ships

Assembling and Regulating Ship's Structure, T. L. Cohee. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 534-536. Rigid supervision and strict check and recheck system necessary to eliminate errors in assembling fabricated ships.

Control of Hull Construction of 5000-Ton Deadweight Fabricated Steel Vessel, "Fabricator." Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 536-538. System employed at yard where straight work was produced at outside shops and furnaced work turned out at yard.

Industrial Management

Putting Our Merchant Ships on Schedule, L. P. Alford. Indus. Management, vol. 56, no. 3, Sept. 1918, pp. 227-230, 7 figs. How principles of industrial management have been applied in controlling ship movements.

Man Power

Manning the New Merchant Marine, Henry Howard. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 499-501. Free schools established for training deck and engine-room

crews for American ships; details of system explained.

Training Workers for Wooden Shipyards. Int. Mar. Eng., vol. 23, no. 9, Sept. 1918, pp. 526-528, 4 figs. New course of instruction organized at Pratt Institute, Brooklyn, N. Y., for woodworkers in shipyards.

Oil Coolers

Multiwhirl Oil Cooler. Power, vol. 48, no. 14, Oct. 1, 1918, p. 489, 2 figs. Description of a watercooled oil-cooler through which oil to be cooled is pumped in a helical path so as to strike the water-filled tubes at right angles.

Passenger Steamers

Twin-Screw Passenger Steamer "Stavangerfjord." Engineering, vol. 106, no. 2746, Aug. 16, 1918, pp. 170-172, 21 figs. Deck plans, elevation, photographs and detailed description of features of the new 13,000-ton steamer built by Cammell, Laird & Co., Ltd., Birkenhead.

Shallow-Water Boats

Solving the Shallow Water Problem, W. V. Kidder. Motor Boat, vol. 15, no. 18, Sept. 25, 1918, pp. 13-14, 4 figs. Boat with flat "shovel" nose set in motion by air propeller in stern.

Standard Vessels

Further German Views on Standard Cargo Vessels, E. Goos. Shipbuilding & Shipping Rec., vol. 12, no. 10, Sept. 5, 1918, pp. 231-232, 1 fig. Considers that German yards, with possible exception of new yards recently built, have little to gain and much to lose by adopting policy of standard shipbuilding. From Schiffbau (Hamburg).

Welded Ships

Electrically Welded Cargo Ships. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 203-210. Review of problems of welding in their application to marine construction and of work being done by U. S. Shipping Board, Emergency Fleet Corporation. From Nauticus.

Evolution of Electric Welding Processes as Applied to Shipbuilding, H. A. Hornor. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 256-263. Electric welding in railway shops; application to steel shipbuilding; British Admiralty investigation; experiments under way in the U. S.; electric welding methods. From Nauticus (special supplement).

Application of Electric Welding to Shipbuilding. Engineering, vol. 106, no. 2747, Aug. 23, 1918, pp. 197-199. Results of a six-months' series of tests and experiments carried out by Lloyd's. Also published in Shipbuilding & Shipping Rec., vol. 12, no. 8, Aug. 22, 1918, pp. 186-188.

Electric Welding as Applied to Steel Ship Construction. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 308-309. Description of work of Electric Welding Committee of Emergency Fleet Corporation. General features of steamer; type of joints; method of assembly; amount of welding required. Also published in Jl. Engrs. Club of Phila., vol. 35-39, no. 166, Sept. 1918, pp. 427-428, and discussion pp. 428-439, 16 figs.

Welding

The Application of Electric Welding to Ship Construction and Repair. Elecn., vol. 81, no. 2102, Aug. 30, 1918, p. 379. A résumé of present practice.

See also Machine Shop (Navy Repairs); Mechanics (Specific-Speed Method).

METAL-WORKING TOOLS

Boring Machines

Defiance No. 5, Horizontal Boring, Milling, Drilling and Tapping Machine. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 400-500, 1 fig. Description, with principal dimensions.

Overhead Flexible Boring Machine. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, p. 160, 2 figs. Illustration of machine designed to meet demand for means of applying the Russell patent screwdriver to pieces of work which cannot be handled under spindle of an ordinary fixed drilling press. Also published in Practical Engr., vol. 58, no. 1640, Aug. 1, 1918, p. 51, 2 figs.

Gear-Cutting Machinery

The Works of the Moss Gear Co. Automobile Engr., vol. 8, no. 116, July 1918, pp. 208-210, 22 figs. Machines used and employed in factory specializing in manufacture of toothed gearing.

Millers

The Kempsmith "Maximiller." Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 595-600, 8 figs. Description of all-geared milling machine built by Kempsmith Mfg. Co., Milwaukee, Wis.

Milling Cutters

Grinding Relief of Milling Cutters. Machy., vol. 25, no. 1, Sept. 1918, pp. 9-10, 7 figs. Comparison of use of disk wheels and cup wheels for grinding milling cutters and an analysis of results obtained.

Nut-Forging Machine

Hollings Indenting Type of Nut-Forging Machine. Machy., vol. 25, no. 1, Sept. 1918, pp. 33-35, 5 figs. Machine which in conjunction with the special bar stock used makes it possible to produce well-formed blanks without excessive pressure and with a relatively small amount of scrap.

Pitch-Measuring Machine

Pitch Measuring Machine for Screw Gauges. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 320-321, 2 figs. Features of Bingham Powell type.

Shell-Boring Lathe

"Galloway" Shell-Boring Lathe. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 544-545, 1 fig. Illustration and principal dimensions.

Taps and Dies

Taps and Dies for Production Work, G. Doorakkers. Engineer, vol. 126, nos. 3269 and 3270, Aug. 23 and Aug. 30, 1918, pp. 151-152 and 186-187, 1 fig. (first and second articles), 5 figs.

Wrigglers

Wrigglers and Their Uses, Hugo F. Pusep. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 559-560, 5 figs. Use of wrigglers in locating points on work to be drilled or milled when a fairly liberal tolerance is allowed.

See also Machine Tools.

MECHANICS

Balancing

The Balancing of Heavy Rotors, M. W. Torbet. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 518-533, 6 figs. Mathematical discussion of forces and couples based on six typical equations of motion.

Beams, Offset

The Design of Offset Beams, Victor M. Summa. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 514-517, 9 figs. Discussion of formulæ used.

Rotation, Rapid

On the Determination of the Resistance to Motion of Rapidly Rotating Machines (Om bestämmande af wastigt roterande maskiners rörelsemotstand), Erik Aug. Fursberg. Teknisk Tidskrift, vol. 48, no. 31, Aug. 3, 1918, pp. 385-389. (To be continued.)

Specific-Speed Method

Design of Water Propellers by the Specific Speed Method, Chas. F. Gross. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 534-546, 5 figs. Presents to draftsmen method of propeller design when given power propeller is to absorb and the speed of advance of propeller through water, items to be determined being diameter, pitch, mean width ratio and blade thickness.

Speed, Critical

Critical Speed in Tapered Shaft Design, Alfred Musso. Machy., vol. 25, no. 1, Sept. 1918, pp. 59-60, 1 fig. Derivation of formulæ and examples illustrating their use.

See also Railroad Engineering, Steam (Shocks in Trains).

METAL ORES

Chromite

Chromite, J. C. Williams. Colo. School of Mines, vol. 8, no. 9, Sept. 1918, pp. 157-159. Foreign and domestic deposits; uses of chromium; alloys; description of chromite; its occurrence and concentration.

Manganese

Manganese Deposits of East Tennessee. The Resources of Tennessee, vol. 8, no. 3, July 1918, pp. 153-207, 10 figs. Report of results of field work by geologists of U. S. Geol. Survey in coöperation with the State Geol. Survey of Tennessee: geography of region; manganese minerals; rocks with which ore is associated; types of deposits; description of typical mines and prospects.

Pyrolusite from Virginia, Thomas L. Watson and Edgar T. Wherry. Jl. Wash. Acad. of Sci., vol. 8, no. 16, Oct. 4, 1918, pp. 550-560, 1 fig. Geology of manganese deposits and crystallography of ore.

Tungsten

Molybdenum, Tungsten and Bismuth. Ind. Australian & Min. Standard, vol. 60, nos. 1552, 1553, 1554, Aug. 8, 15 and 22, pp. 210-211, 245-247, and 284. Treatise on these minerals. Aug. 8: Molybdenite occurrences in Northern Europe, South America, and South Africa; geographical distribution of wulfenite. Aug. 15: list of wulfenite occurrences in United States. Aug. 22: occurrences of wulfenite in Central and Southern Europe, and Australasia.

See also Steel and Iron (Iron-Titanium Ores), (Ore Resources).

METALLURGY

Aircraft

The Metallurgist and the Aircraft Program (III), H. F. Wood. Am. Drop Forger, vol. 4, no. 8, Aug. 1918, pp. 318-319. Suggestions on selection and testing of engine parts; responsibility of metallurgist on success of an airplane engine. From paper before Steel Treating Research Soc.

Tin

The Taylor Concentrator for Tin Slime, J. Waring Partington, Queensland Government Min. Jl. vol. 19, no. 219, Aug. 15, 1918, pp. 352-353 and 359-360, 3 figs. Consists of 24 rectangular concentrating surfaces attached to, and revolving with, a central vertical shaft, the latter being provided at its upper extremity with a worm gearing by means of which motion is imparted to frame. Machine designed in effort to eliminate disadvantages of usual type of revolving wooden round frame.

Wastes

Recuperation and Utilization of Wastes in the Manufacture of Copper, Zinc, Lead, Tin, Aluminum and Their Alloys (La récupération et l'utilisation des déchets de cuivre, zinc, plomb, étain, aluminum et de leurs alliages), Paul Razons. Génie Civil, vol. 73, nos. 9 and 10, Aug. 31 and Sept. 7, 1918, pp. 171-174, 8 figs., and pp. 184-188, 1 fig. Aug. 31: Apparatus for recuperating copper vapors in copper works; method of washing copper filings. Sept. 7: usage of copper waste in the manufacture of cupric sulphate; remelting of bronze filings; by-products of zinc works and recuperation of zinc from refuse of galvanized iron. (To be continued.)

Zinc

Electrothermal Metallurgy of Zinc (La métallurgie électrothermique du zinc), J. Escard. Génie Civil, vol. 73, nos. 7, 8 and 9, Aug. 17, 24 and 31, 1918, pp. 124-127, 3 figs., pp. 141-146, 9 figs., and pp. 168-171, 5 figs. Aug. 17: Coal-reduction methods, De Laval and Johnson furnaces. Aug. 24: Condensation of zinc vapors; decomposition of zinc sulphide by iron; industrial furnaces. Aug. 31: Results obtained with Côte and Pierron furnaces; Peterson's process; Thomson-Gerald furnace; Snyder furnace.

MILLWRIGHTING

Belt Clearances

Belt Clearances for Oblique Drives, F. R. Parsons. Nat. Engr., vol. 22, no. 9, Sept. 1918, pp. 419-420, 3 figs. Description of setting out floor clearances and difficulties encountered; hints on how to do such work correctly. From Mech. World.

Shafting

Aligning and Erecting Shafting (I). Ironmonger, vol. 164, no. 2338, Sept. 7, 1918, p. 42, 4 figs. Supplementing information in series on belt-driving practice published June 29, July 6, and Aug. 10.

MILITARY ENGINEERING

Artillery

Calculation of a Long Range Gun (Note sur le calcul d'un canon à longue portée). Génie Civil, vol. 73, no. 10, Sept. 7, 1918, pp. 191-192, 1 fig. Calculation of characteristics of trajectory for 100 km. range; mechanical requirements of projectile.

Contract Organization

Contract Organization Vitally Important for War Work, Francis Donaldson. Eng. News-Rec., vol. 81, no. 12, Sept. 19, 1918, pp. 535-538. Large-scale government construction demands most careful coördination of forces; charts setting forth organization of two typical contracts.

Electrical Machinery

Electrical Developments for American Army, R. K. Tomlin, Jr. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 532-536, 8 figs. Present plans for troops in France provide for 50,000 kw.; technical board controls supplies and coördinates work of design

and construction; electrical machinery difficult to get.

Mine Safety Appliances

Mine Safety Appliances in Warfare, F. H. Trego. Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 504-505. Account of mine safety appliances which have been adapted by War Department for use in war.

Railways, Military

Operation of the U. S. Military Railways in France, J. G. Porter. Ry. Age, vol. 65, no. 12, Sept. 20, 1918, pp. 549-551. How Americans adapted themselves to new transportation conditions encountered overseas.

Rifles

Temporary Small-Arms Repair Shop in France, R. K. Tomlin, Jr. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 535-536, 3 figs. Description of repair shop for salvaging rifles.

The Science of the Rifle, F. H. Kelly. Arms & Explosives, vol. 26, no. 312, Sept. 2, 1918, pp. 117-120, 2 figs. Action of bolt magazine and trigger parts. From writer's book under same title.

Sanitary Engineering

Water Supply Fire Protection, Roads and Waste Disposal of a Large Training Camp, Murray Warner. Am. City, vol. 19, no. 3, Sept. 1918, pp. 174-176, 1 fig. Distribution system of water supply based on standard daily allowance of 55 gal. per man; machines used in the five fire stations; sewage and garbage disposal.

Small Arms

Revolvers and Automatic Pistols (Les revolvers et les pistolets automatiques), L. Cabanès. Génie Civil, vol. 73, nos. 8 and 9, Aug. 24 and 31, 1918, pp. 146-150, 7 figs., and pp. 165-167. Aug. 24: English Gabbett-Fairfax model; American Colt 38; characteristics of Colt 45. Aug. 31: Classification of various types in order of merit; choice of pocket pistol for personal defense in peace times; choice for war service; automatic Colt 45.

Substations

The Outdoor Substation in War Service, E. B. Meyer. Elec. World, vol. 72, no. 12, Sept. 21, 1918, pp. 537-541, 9 figs. Through its use the sudden demand for power to supply war industries has been promptly met with a resulting conservation of material and labor.

Supply Bases

Army Intermediate Depot in France Problem in Getting Labor and Supplies, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 11, Sept. 12, 1918, pp. 478-483, 11 figs. Project covers site six miles long; three types of warehouses being built; Chinese labor used on railroad grading; installation completed for storing 5000 tons of beef at zero temperature.

Boston Army Supply Base Will Be Valuable Permanent Port Terminal. Eng. News-Rec., vol. 81, no. 12, Sept. 19, 1918, pp. 522-526, 5 figs. Description of storage warehouse in Boston having 60 acres of storage space.

Troop Transportation

A Novel Scheme for Carrying Troops by Rail, Frederick C. Coleman. Ry. Age, vol. 65, no. 11, Sept. 13, 1918, pp. 509-511, 5 figs. The Great India Peninsula Railway of India's military cars, holding 66 soldiers each, described.

Military Trains in India. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, pp. 232-236, 13 figs. Plans and interior arrangement of carriages.

See also Mines and Mining (Explosives); Munitions.

MINES AND MINING

Asphalt

Asphalt Deposits and Oil Conditions in Southwestern Arkansas, Hugh D. Miser and A. H. Purdue. U. S. Geol. Survey, Bul. 691-J, Contributions to Economic Geology Part II, Aug. 16, 1918, pp. 271-292, 1 fig. Geography and geology; general features and local details of asphalt deposits; drilling for oil; well records.

Blackdamp

Outbursts of Gas in Crowsnest Field, James Ashworth. Coal Age, vol. 14, no. 10, Sept. 5, 1918, pp. 443-446, 3 figs. Description of violent gas outbursts which have caused coal fields to be shut down; theories advanced to account for outbursts; suggestions for proceeding with work. Abstract of pamphlet entitled Outbursts of Explosive Gases in the Crowsnest Pass Coalfield, British Columbia.

The Origin of Blackdamp, J. I. Graham. Trans. Instn. Min. Engrs., vol. 55, part 4, Aug.-Sept. 1918, pp. 303-312. Experiments from which author formulates four ordinary compositions of blackdamp resulting from different contributory causes.

Briquetting of Ores

Briquetting of Powdery Ores and of Blast Furnace Dust (Le briquetage des minerais pulvérulents et des poussières de hauts fourneaux). Génie Civil, vol. 73, no. 7, Aug. 17, 1918, pp. 131-134, 10 figs. Schumacher process; Fawcet, Sutcliffe and Speakman presses; nodulation and agglomeration processes.

Cementation

The François Cementation Process, A. H. Krynauw. Min. Mag., vol. 19, no. 2, Aug. 1918, pp. 68-77, 10 figs. Cases in which cement grout under pressure has been successfully applied and manner in which this has been done. From paper before Chem., Metallurgical, and Min. Soc. of So. Africa.

Explosives

Some Notes on Experiments Made with a View to Reducing the Consumption of Explosives, and Increasing the Fathoms Broken per Machine Shift in Machine Stoping, T. H. Bayldon. Jl. So. African Instn. Engrs., vol. 16, no. 12, July 1918, pp. 226-233, 2 figs. Tables comparing two methods: (1) drilling alternately on two stope faces and doubling size of benches, (2) cutting four three-hole benches for each machine on each face.

Man Power

Mechanical Equipment and the Conservation of Miners, R. L. Herrick. Compressed Air Mag., vol. 23, no. 9, Sept. 1918, pp. 8876-8881, 7 figs. Typical examples of manpower savings observed by writer on a 450-mile automobile trip about the mines in the anthracite district.

Salt

Salt Mining and Dressing, J. B. Calkins. Eng. & Min. Jl., vol. 106, no. 10, Sept. 7, 1918, pp. 431-435, 7 figs. Brief history of salt industry, with detailed account of mining and milling operations at a property in New York State having an output of 2000 tons of prepared salt in a 10-hr. day; details as to haulage, dressing and mechanical treatment.

Shale Oil

The Extraction of Oils from Shales and Coal. Petroleum Rev., vol. 39, no. 836, July 27, 1918, p. 59. New English patented process consisting in mixing powdered shale or coal both with some finely ground material (such as limestone, dolomite, carbonate of magnesium or barium carbonate), which, under the action of heat, will give off carbonic acid gas, and with small iron scrap (such as iron turnings) or its chemical equivalent for the purpose of causing the release of increased quantities of hydrogen.

See also Safety Engineering (Mine Accidents).

MOTOR-CAR ENGINEERING

Chassis

Military Transport Chassis (VII). Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 267-270, 4 figs. Details of F. W. D. (Model B) 3-ton chassis.

Fuels

The Valuation of Motor Fuels, Harold Moore. Automobile Engr., vol. 8, no. 118, Sept. 1918, pp. 245-248. Relative value of tests: specific gravity, viscosity, cold test, coke test, fractional distillation, specific heat, iodine and bromine values, ultimate analysis, temperature of spontaneous ignition, explosive range, calorific power.

Use of Gas for Automobiles. Gas Age, vol. 42, no. 5, Sept. 2, 1918, pp. 199-200. French discussion upon intensive trials both in England and France made with automobiles driven with illuminating gas.

Gear Changing

A Mechanism for Changing Gears Automatically. Automotive Ind., vol. 39, no. 10, Sept. 5, 1918, pp. 416-417, 4 figs. Gears shifted and clutch operated by engine power.

The Problem of the Gear Box. Auto, vol. 23, no. 35, Aug. 30, 1918, pp. 625-626. Inquiry of conditions limiting possibilities in design. (To be continued.)

Racing Cars

The 300 H.P. Fiat Racer. Autocar, vol. 41, no. 1189, Aug. 3, 1918, pp. 117-118, 1 fig. Dimensions and history.

Spark Plugs

How Automobile Spark Plugs Are Made. Commercial America, vol. 15, no. 3, Sept. 1918, pp. 33-37, 7 figs. Cold-drawing and automatic machine process; making porcelain; experimenting; testing and assembling.

Steering

Problems in Steering of Motor Cars Discussed from the Point of View of Projective Geometry (Anwendung eines Satzes der projektiven Geometrie auf die Lenkung von Automobilen), C Veithen. Dingler's Polytechnisches Journal, vol. 333, no. 2, Jan. 26, 1918, pp. 9-10, 3 figs.

Three-Wheel Cars

The Morgan Runabout. Autocar, vol. 41, no. 1189, Aug. 3, 1918, pp. 123-124, 4 figs. Brief description of a three-wheeled light car.

Trailers

Development of the Trailer. Sibley Jl. of Eng., vol. 32, no. 12, Sept. 1918, pp. 180-183, 2 figs. Experimental basic trailing laws; steering.

Valve Design

Four Valves Per Cylinder. Autocar, vol. 41, no. 1195, Sept. 14, 1918, p. 264. Six-cylinder Pierce-Arrow engine with 12 inlet and 12 exhaust valves in side pockets.

See also Internal-Combustion Engineering; Machine Shop (Radiator Manufacture), (Wheel Hubs); Safety Engineering (Headlights, Automobile).

MUNICIPAL ENGINEERING

Catch-Basin Cleaning

Catch-Basin Cleaning in Chicago. Mun. Jl., vol. 45, no. 11, Sept. 14, 1918, pp. 199-200. Itemized costs of work done by hand and by auto-eductor, time of cleaning different basins.

City Planning

The Planning of the New Halifax, Thos. Adams. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 680-683, 3 figs. Plans and details of six schemes, two for city and four for county.

The St. Louis Zone Plan, Harland Bartholomew. Jl. Engrs. Club of St. Louis, vol. 3, no. 4, July-Aug. 1918, pp. 214-240, 5 figs. Provisions of city building zone plan passed by Board of Aldermen.

Salvage

Municipal Salvage, J. C. Dawes. Surveyor, vol. 54, no. 1390, Sept. 6, 1918, pp. 111-112. Possibilities of utilizing ordinary house refuse. Inst. of Cleansing Superintendents. (To be concluded.)

Street Lighting

The Aesthetics of Street Lighting, M. Luckiesh. Trans. Illuminating Eng. Soc., vol. 13, no. 6, Aug. 30, 1918, pp. 355-356. Abstract of paper before Phila. Section of the Soc.

MUNITIONS

Canada

Canada's Production of Munitions of War. Can. Min. Jl., vol. 39, no. 17, Sept. 1, 1918, pp. 295-296. Summary of work of Imperial Munitions Board, with a few details regarding most important departments.

Explosives

Sengite: A New Explosive, J. P. Udal. South African Min. Jl., vol. 27, part 2, no. 1401, Aug. 3, 1918, p. 307. Process of manufacturing explosive made of gun coton impregnated with nitrate of soda.

Fuses

Making the Mark III Detonating Fuse. Edward K. Hammond. Machy., vol. 25, no. 1, Sept. 1918, pp. 27-32, 9 figs. First of a series describing operations involved.

Guns

Lathes for the Present Gun Program, A. L. De Leeuw. Am. Mach., vol. 49, no. 11, Sept. 12, 1918, pp. 491-493. Suggestions for obtaining at once required lathes for manufacture of guns.

The British 6-Inch Howitzer, I. W. Chubb. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 605-612, 16 figs. Body and breach mechanism; various turning, boring, rifling and planing operations are described. (Third article.)

Helmets

Ancient Helmet Making, H. H. Manchester. Am. Mach., vol. 49, no. 12, Sept. 19,

1918, pp. 503-507, 28 figs. A résumé of art of making helmets from earliest times.

Machine Guns

The Manufacture of the Lewis Machine Gun, Frank A. Stanley. Am. Mach., vol. 49, no. 12, Sept. 19, 1918, pp. 529-531, 9 figs. Thirteenth article describing manufacture of Lewis machine fun. Second article on the barrel, describing chambering, lapping and inspection.

Shells

Government Requires Millions of Gas Shells. Foundry, vol. 46, no. 10, Oct. 1918, pp. 441-442. Program of Government for next twelve months.

Rectifying Rough Bored 155-mm. Shells, M. P. Potter. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 297, 5 figs. Type of head developed after Government requirements.

Making the U. S. 8-in. Shell, M. E. Hoag. Am. Mach., vol. 49, nos. 11 and 12, Sept. 12 and 19, 1918, 9 figs, and 457-460, 11 figs. Describes turning and boring. (Serial.)

Labor-Saving Washing Device Used on Shell Work, J. H. Rodgers. Can. Machy., vol. 20, no. 9, Sept. 5, 1918, p. 299. Arrangement by which shells are subjected to a spray wash of soda solution, followed by a rinsing with clear hot water.

See also Military Engineering (Rifles). (Small Arms).

PHYSICS

Air

Physics of the Air, W. J. Humphreys. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 341-370, 6 figs. Discussion of crushing of hollow conductors by lightning discharges; quantity of electricity in discharge; general rules for construction of an efficient system of lightning protection; electrical field of the earth; electrical conductivity of the atmosphere; ionic content of the air. (Continuation of serial.)

Luminous Materials

On the Luminescence Due to Radio-Activity, Enoch Karrer and D. H. Kabakjian. Jl. Franklin Inst., vol. 186, no. 3, Sept. 1918, pp. 317-340, 17 figs. Quantitative data on rejuvenation of self-luminous materials, and in particular of radium bromide.

PIPE

Corrosion Prevention

The Deactivator System for Elimination of Corrosion in Hot Water Supply Pipes. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 297-299, 1 fig. Description of an experimental plant installed in an apartment house in Boston and results obtained. Installation made by Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology in coöperation with Research Department of National Tube Co.

Discussion Concerning the Destruction of Gas and Water Piping in Clayey Soils Containing Gypsum (Zur Zerstörung der Gas- und Wasserleitungen in gipshaltigem Lehmboden), P. Medinger. Journal für Gasbeleuchtung, year 61, nos. 7 and 8, Feb. 16 and 23, 1918, pp. 73-76, 1 fig., and pp. 89-91, 3 figs. Extensive discussion of the underlying chemical phenomena.

Wood

Redwood Pipe and Its Uses. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, p. 32, 1 fig. Processes of making three principal types in present use.

See also Wood (Pipes).

POWER GENERATION AND SELECTION

Coal Mining

Electricity in Coal-Mining Operations, Frank Huskinson. Elec. World, vol. 73, no. 13, Sept. 28, 1918, pp. 494-495. Mine signaling and telephone systems; data on rope haulage; miscellaneous applications.

The Electrification of a Durham Colliery. Engineer, vol. 126, no. 3268, Aug. 16, 1918, pp. 136-138, 4 figs. Description of electrical equipment of a British colliery.

Combined Power

Economic Proportion of Hydroelectric and Steam Power, Frank G. Baum. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 450-451, 2 figs. New method of determining economical proportion of hydroelectric to steam power. From paper before Am. Inst. of Elec. Engrs.

Efficiency

Efficiency in Power Production, M. T. Borja. Aera, vol. 7, no. 2, Sept. 1918, pp. 175-177, and (discussion) pp. 177-178. Suggestions to engineers. (Manila Elec. Ry. & Light Co.)

Electricity

Industrial Applications of Electricity, Dwight D. Miller. Elec. Contractor-Dealer, vol. 17, no. 12, Oct. 1918, pp. 123-128, 2 figs. Examples of uses of electric heat; advantages of electric drive-friction losses, greater output for a given time, flexibility of operation, lighter building construction, safety.

Exhaust Steam

Utilization of Exhaust Steam in Collieries for the Production of Electrical Energy. (Considérations sur l'utilisation des vapeurs échappement dans les houillères en vue de la production d'énergie électrique), A. Barjou. L'Industrie Electrique, year 27, no. 628, Aug. 25, 1918, pp. 308-312, 5 figs. Diagram and formula to determine steam consumption of low-pressure turbines; scheme of connections for a turbo-alternator group, 625 kva, 5000 volts. (Continuation of serial; former installments in no. 621, p. 166, no. 623, p. 212, and no. 627, p. 287.

Mining

Electricity in Mining, L. Fokes. Sci. & Art of Min., vol. 29, no. 2, Aug. 24, 1918, pp. 18-20, 5 figs. Safe operation of signaling apparatus; signaling circuits. (Continuation of serial.)

Motor Selection

Applying Engineering Principles Properly in Motor Selection, C. W. Squier. Elec. Ry. Jl., vol. 52, no. 12, Sept. 21, 1918, pp. 505-508, 14 figs. How to compare electric motors which appear to have the necessary characteristics for service designated and to select the one best adapted to meet given requirements.

Oil Fields

The Application of Electrical Power to Oilfield Requirements, J. Wilfred Burford. Jl. Instn. Petroleum Technologists, vol. 4, no. 16, June 1918, pp. 229-262, 4 figs., and (discussion) pp. 262-276. Economics gained by installation of electrical machinery; requirements of petroleum-producing industry; field this industry offers to manufacturers of electrical machines.

Printing

Electrically-Driven Printing Presses. Engineer, vol. 126, no. 3268, Aug. 16, 1918, 9 figs. Illustrations of arrangements and controllers; wiring diagrams.

Power Industry

Conditions in the Power Industry, L. W. Schmidt. Power, vol. 48, no. 14, Oct. 1, 1918, pp. 486-488. Digest of reports of United States consuls on power situation in various parts of world and influence of war upon this industry.

Water Works

Electric Drive for Water Works (Der elektrische Antrieb von Wasserversorgungsanlagen), Wintermeyer. Journal für Gasbeleuchtung, year 61, nos. 11 and 12, Mar. 16 and 23, pp. 126-128, 6 figs, and pp. 137-142, 10 figs. Discussion with diagrams of motor-generator connections.

Wind Power

The Use of Wind Power (Om udnyttlese af vindkraften), H. C. Vogt. Ingeniören, vol. 27, no. 65, Aug. 14, 1918, pp. 451-452, 2 figs. (Continued from June 8.)

POWER PLANTS

Auxiliaries

Motor-Driven Auxiliaries, C. Grant. Mech. World, vol. 64, nos. 1648 and 1651, Aug. 2, and Aug. 23, 1918, pp. 52-53, and p. 88. Aug. 2: Rotary air-pumps; circulating pumps. Aug. 23: Remarks on operation of feed pumps; chimney draft fans; generator cooling fans.

Cedar Rapids, Steam

Cedar Rapids Big Steam Plant. Power, vol. 48, no. 14, Oct. 1, 1918, pp. 478-485, 13 figs. Description of 16,000-kw. steam-turbine plant, with list of principal equipment.

Chimneys

Graphic Method of Chimney Design, H. M. Brayton. Power, vol. 48, no. 10, Sept. 3, 1918, pp. 349-350, 3 figs. Method of designing chimneys without calculations by use of charts and curves.

Rusting Steel Chimneys Coated with Concrete by Cement Gun. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 596-597, 3 figs. Reinforced-concrete shell is applied to outside of steel stacks.

Cincinnati, Steam

Cincinnati's New 100,000-Kilowatt Power Station. Elec. Rev., vol. 73, nos. 11 and 12, Sept. 14 and 21, 1918, pp. 397-400, 5 figs., and pp. 439-441, 5 figs. First installment describing station layout and mechanical equipment of Union Gas & Electric Company's new station with initial capacity of 50,000 kilowatts. Also published in Power, vol. 48, no. 10, Sept. 3, 1918, pp. 337-344, 14 figs.

Engine House

Rectangular Engine House Avoids Use of Turntable. Eng. News-Rec., vol. 81, no. 13, Sept. 26, 1918, pp. 593-594, 3 figs. Reinforced-concrete building has arched roof on timber lattice trusses; engine stalls have swinging doors.

Feedwater Heater

The Swartwout Feed-Water Heater and Receiver. Steam, vol. 22, no. 3, Sept. 1918, p. 80, 1 fig. Automatic apparatus designed to heat feedwater by use of exhaust steam.

Flexibility

Flexibility of Industrial Power Plants. Southern Engr., vol. 30, no. 2, Oct. 1918, p. 57, 1 fig. Typical connection diagram utilizing rotary converters for tying alternating and direct-current generators together.

Indicating Instruments

Management of the Power Plant, Robert June. Textile World Jl., vol. 54, no. 14, Oct. 5, 1918, pp. 77-81, 5 figs. Use and purpose of indicating instruments. Fourth of series.

Inspection

Need and Value of Boiler Inspection, A. L. G. Taylor. Power, vol. 48, no. 11, Sept. 10, 1918, pp. 389-390. Some instances of unsafe equipment revealed by inspection.

The Massachusetts Plan of Power-Plant Inspection and Coal Conservation, Thomas Hawley. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 302-304. An exposition of plan to be followed in Massachusetts.

Mansfield, Coal and Natural Gas

More Energy for Mansfield District. Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 733-738, 12 figs. Description of new plant of Mansfield Electric Light & Power Co. at Melco, Ohio, using both natural gas and coal.

Montana, Hydroelectric

New Hydroelectric Plant of Montana Power Company, W. A. Scott. Elec. Rev., vol. 73, no. 13, Sept. 28, 1918, pp. 487-490, 2 figs. Details of recently completed Holter project.

Pennsylvania Salt Co., Steam

New Plant of the Pennsylvania Salt Manufacturing Company. Power, vol. 48, no. 12, Sept. 17, 1918, pp. 406-413, 10 figs. Description of a modern steam-turbine alternating-current plant with rotary-converter transformation to direct-current for electrolytic work.

Records

Power Plant Records of Operation, Ralph E. Turner. Power Plant Eng., vol. 22, no. 19, Oct. 1, 1918, pp. 799-803, 4 figs. Report sheets designed to aid engineer in obtaining and maintaining highest efficiency.

Rochester, Hydroelectric

Hydroelectric Development at Rochester. Power Plant Eng., vol. 22, no. 19, Oct. 1, 1918, pp. 779-782, 8 figs. Description of features of an hydroelectric plant.

Vibration

Prevention of Vibration in Power and Ventilation Plants, Charles L. Hubbard. Power Plant Eng., vol. 22, no. 19, Oct. 1, 1918, pp. 782-785, 11 figs. Causes of vibration and forms of foundations, supports, hangers and connections to prevent communication to building structure.

See also Chemical Technology (Water Softening); Hoisting and Conveying (Coal Handling).

PUMPS

Motor-Driven Pumps

Motor-Driven Pumps, Chas. Lawson. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 66-73, 6 figs. Pumping data; lift of pumps and pump control.

Triplex Pumps

Triplex Pumps, John H. Perry. Domestic Eng., vol. 84, no. 8, pp. 275-276, and 306, 4 figs. A few of the different kinds and how they work.

RAILROAD ENGINEERING, ELECTRIC

Circuit Breakers

High-Speed Circuit Breakers for Chicago, Milwaukee & St. Paul Electrification, C. H. Hill. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 623-626, 5 figs. Details of construction.

Cripples

The Disabled Soldier in Electric Railway Service. Electric Ry. Jl., vol. 52, no. 13, Sept. 28, 1918, pp. 579-582, 10 figs. Reclaiming the disabled soldier; blind men winding coils; one-armed men doing shop work.

Freight Transportation

The Problem of Freight Haulage, Harlow C. Clark. Aera, vol. 7, no. 2, Sept. 1918, pp. 103-106. Summary of electric railway freight situation in its connection with national transportation; causes preventing use of many miles of available track.

Locomotives

Advantages of Storage-Battery Locomotives, C. W. Chappelle. Coal Age, vol. 14, no. 10, Sept. 5, 1918, pp. 437-442, 3 figs. Paper read before Illinois Min. Inst., Peoria, Ill., May 1918, and discussion which followed.

Determination of the Proper Size of Storage-Battery Locomotive, Dever C. Ashmead. Coal Age, vol. 14, no. 12, Sept. 19, 1918, pp. 548-552, 2 figs. Explaining calculations of draw-bar pull and battery capacity.

Electric Shunting Locomotive, Lancashire & Yorkshire Ry. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, p. 237, 1 fig. Particulars of an electric locomotive designed for shunting service at Clifton power station.

Rewinding and Testing Direct-Current Locomotive Armatures, Frank Huskinson. Coal Age, vol. 14, no. 12, Sept. 19, 1918, pp. 541-544, 16 figs. How mine-locomotive armatures may be rewound.

RAILROAD ENGINEERING, STEAM

Ballasting

A Typical Rock Ballasting Organization, F. H. C. Graves. Ry. Maintenance Engr., vol. 14, no. 9, Sept. 1918, pp. 310-311, 1 fig. Account of work done recently on a double-track eastern road with dense traffic.

Bolsters

Effect of Holes in the Sides of Box Bolsters, L. E. Endsley. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 507-508, 3 figs. Results of a series of tests made on a box bolster with and without holes in the sides.

Brakes

Brake Performance with Heavy Trains. Ry. Gaz., vol. 29, no. 10, Sept. 6, 1918, p. 254. Remarks upon requirements of an efficient brake system based upon results obtained by the Virginian Ry. and described in same issue.

Car Cleaning

Passenger Car Cleaning on the Canadian Pacific Railway, E. Eley. Can. Ry. & Marine World, no. 248, Oct. 1918, p. 432. Description of process. Paper before Can. Ry Club, Montreal.

Car Lighting

Lighting of Railroad Cars by Coal Gas (Die Beleuchtung der Eisenbahnwagen mit Steinkohlengas), O. Hübner. Dingler's Polytechnisches Journal, vol. 333, no. 2, Jan. 26, 1918, pp. 10-12. From Journal für Gasbeleuchtung, year 59, pp. 417-425 and 435-439. Abstract of an extensive paper.

Cars, Passenger

New Cars for Special and Excursion Traffic. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, pp. 159-160, 3 figs. General design of 26-ton, 82-passenger car prepared for Victorian Railways.

Cars, Standard

Railroad Administration's Standard Baggage Cars. Ry. Age, vol. 65, no. 13, Sept. 27, 1918, pp. 584-586, 3 figs. Details of designs for 60-ft. and 70-ft. cars of all-steel construction.

Steel Baggage Car for the United States Railroad Administration. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 341-343, 4 figs. General description of design adopted for all-steel 70-ft. baggage cars.

Cars, Wooden

Large Capacity Wooden Hopper Car. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 509-512, 3 figs. Drawings and general data with description of wooden hopper car built by the N. & W.

Cranes

Gasoline Traveling Crane for Railroad Ash Pits. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1918, pp. 305-307, 4 figs. General features of machines used by New York Central.

Draft Gear

Proper Draft Gear Maintenance, L. T. Canfield. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 460-462, 2 figs. Report of five tests of gears; recommendations as to inspection and repair. Paper read before Car Foreman's Assn. of Chicago, Sept. 1918.

Firing

Mechanical Stoking of Locomotives as Related to Smoke, W. S. Bartholomew. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 339-341. Résumé of stoker firing practice citing general points of advantage over hand firing, as well as specific instances in support of these claims. Read before Smoke Prevention Assn. at Newark, N. J., Aug. 22.

Freight Handling

The Mechanical Handling of Goods on Railways. Ry. Gaz., vol. 29, no. 10, Sept. 6, 1918, pp. 258-261, 14 figs. Handicaps imposed by wartime conditions on handling railway goods to rail truck from trader or Government consignee and vice versa.

Locomotives

Locomotive Stokers and Smoke Prevention, W. S. Bartholomew. Ry. Age, vol. 65, no. 10, Sept. 6, 1918, pp. 451-453. Résumé of stoker firing practice citing general points of advantage over hand firing, as well as specific instances in support of these claims. Read before Smoke Prevention Assn., Newark, N. J., Aug. 22.

Locomotive Terminal Detention Records. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, pp. 241-242. Forms used by the Pennsylvania for gathering information regarding locomotive delays at terminals.

Making Good Engines Better on the Delaware, Lackawanna and Western. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1918, p. 319, 3 figs. Results obtained from engines fitted with "Universal" steam chests and valves.

Renewable Stayheads for Locomotive Fireboxes. Engineer, vol. 126, no. 3270, Aug. 30, 1918, pp. 176-177, 5 figs. Description of a new renewable staybolt head and report of experiments and tests made upon it.

Results of Road Tests of N. & W. Mallet Locomotive, H. W. Reynolds. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 502-503, 3 figs. General data on boiler, engine and locomotive performance, and results of tests.

Superheater Locomotive Performance. Ry. Age, vol. 65, no. 11, Sept. 13, 1918, pp. 498-499. 1 fig. Importance of maintenance; clean flues; dampers; effects of high water; lubrication and drifting.

Ten-Wheel and Mikado Type Locomotives for the Paris-Orleans Ry., F. C. Coleman. Ry. Rev., vol. 63, no. 8, Aug. 24, 1918, pp. 267-268, 2 figs. Description of two designs of locomotives recently introduced into heavy freight and passenger service in France.

Terminal Handling of Locomotives, H. C. Pickard. Can. Ry. & Marine World, no. 248, Oct. 1918, pp. 421-424, 11 figs. Suggestions regarding conservation of man power in cleaning fires in locomotives.

The Design and Uses of Tank Locomotives. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, pp. 161-164, 6 figs. Claimed advantages of tank locomotives. Diagram drawings of the 0-6-4, 2-6-4, 4-6-2, 4-4-4 and 4-6-4 types.

Locomotives, Standard

Heavy Mikado Type Locomotive, United States Railroad Administration. Ry. Rev., vol. 63, no. 10, Sept. 7, 1918, pp. 331-334, 5 figs. Descriptive reference to first of heavy Mikado type locomotives to be constructed for U. S. R. R. Administration. Comparison with leading details of light Mikado type.

Heavy Standard Mikado Locomotive. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 491-494, 7 figs. General description and principal data, with drawings.

Tonnage Rating of the Standard Locomotives, H. S. Vincent. Ry. Age, vol. 65, no. 14, Oct. 4, 1918, pp. 627-631, 3 charts. Charts of tonnage rating for U. S. Standard light Mikado, heavy Mikado and 8-wheel switching locomotives, with tables of frictional resistances of freight and passenger cars.

The U. S. Standard Heavy Mikado Type Locomotive. Ry. Age, vol. 65, no. 9, Aug. 30, 1918, pp. 375-376, 4 figs. General description, with drawings and principal data.

Rails

On the Stiffness and Relative Strength of Rails, E. W. Stoney. Indian Eng., vol. 63, no. 22, June 1, 1918, p. 304, 6 figs. Diagrams showing plots of results of experiments on deflection of rails in various positions by central dead loads.

Transverse Rail Fissues and the Derailment at Juniper, Ga. Ry. Rev., vol. 63, no. 9, Aug. 31, 1918, pp. 305-309, 9 figs. From report of engineer-physicist of Bureau of Safety, Interstate Commerce Commission, on failure by breaking in several places of a 12-year old 80-lb. A. S. C. E. section rail.

Salvage

Reclamation on the Southern Pacific, Frank A. Stanley. Ry. Mech. Eng., vol. 92, no. 9, Sept. 1918, pp. 505-506, 5 figs. Second installment. Description of extensive salvage work.

Shocks in Trains

Shocks in Long Passenger Trains, Robert Burgess. Southern & Southwestern Ry. Club, vol. 14, no. 10, July 1918, pp. 4-20 and (discussion) pp. 20-31. Causes producing them; suggestions to engine men.

Signals

Train Operation by Signal Indication on the Erie Railroad, Henry M. Sperry. Ry. Gaz., vol. 29, no. 9, Aug. 30, 1918, pp. 227-231, 4 figs. Summary of disadvantages experienced under manual block and improvement in train operation under automatic block. From the Railway Age.

Sleepers

The Green-Moore Patent Resilient Reinforced Concrete Sleepers. Ry. Gaz., vol. 29, no. 10, Sept. 6, 1918, pp. 262-264, 10 figs. Figures and illustrations. Other concrete sleepers have been described in issues of May 13 and July 19, 1918.

Snow

Maintaining a Railroad Above the Clouds. Ry. Maintenance Engrs., vol. 14, no. 9, Sept. 1918, pp. 291-295, 9 figs. Problems encountered in handling snow and ice to keep open the Moffatt line reaching an elevation of over 11,000 ft.

The Southern Pacific's Snow Shed Problem, Geo. W. Rear. Ry. Gaz., vol. 29, no. 6, Aug. 9, 1918, pp. 158-159. Brief history of development of 29 miles of snow sheds and of problems involved in their maintenance. From Proc. Am. Ry. Bridge & Building Assn., 1917.

Superheaters

Superheater Unit Maintenance. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 479-482, 9 figs. Instructions for installation and care of superheater units. From Bulletin No. 4, by Locomotive Superheater Co., New York.

Terminals

Unit Operation of Railroad Terminals. Ry. Rev., vol. 63, no. 13, Sept. 28, 1918, pp. 455-458. From Preliminary Report of Committee on Yards and Terminals, Am. Railway Eng. Assn., issued in Bulletin 208.

Yards, Gravitation

Colwick Gravitation Yards, Great Northern Ry. Ry. Gas., vol. 29, no. 7, Aug. 16, 1918, pp. 185-188, 5 figs. Plan and views of yard instituted for concentrating and remarshalling coal traffic to and from Notts and Derby mines.

See also Factory Management (Stores); Safety Engineering (Railroad Administration Safety Work); Testing and Measurements (Track Scales).

REFRACTORIES

Brick, Inspection

Inspecting Refractory Brick, C. E. Nesbitt and M. L. Bell. Iron Age, vol. 102, no. 11, Sept. 12, 1918, p. 630. Standard specification a necessity; results of some tests. From a paper before Am. Soc. for Testing Materials, June 1918.

Brick, Silica

The Manufacture of Silica Brick, H. Le Chatelier and B. Bogitch. Bul. Am. Inst. Min. Engrs., no. 141, Sept. 1918, pp. 1435-1462, 14 figs. Experiments on samples of a few grams conducted at the Sorbonne, Paris, for the purpose of determining necessary conditions in manufacture of high-grade brick.

High-Temperature Research

High Temperature Processes and Products (III), Chas. A. Darling. Jl. Royal Society of Arts, vol. 66, no. 3433, Sept. 6, 1918, pp. 649-656, 2 figs. Alundum and aloxite; artificial graphite; British processes; high-temperature research.

Structure

The Importance of Structure in Refractories, F. H. Kirkpatrick. Clay-Worker, vol. 70, no. 2, Aug. 1918, pp. 137-139, 6 figs. Effect of structure on the ultimate quality of manufactured product. From the Effect of Size of Grog in Fire Clay Bodies, tech. paper 104, Bureau of Standards.

Volatilization

Relative Volatilities of Refractory Materials, Wm. Roy Mott. Gen. Meeting Am. Electrochem. Soc., Oct. 2, 1918, Advanced Copy, Paper 1, pp. 1-34, 6 figs. Experimental study of order in which substances volatize in electric arc, distances at which their vapors condense from arc, and time to volatilize equal atomic quantities of elements or molecular quantities of compounds; theoretical considerations concerning ratios of absolute boiling points to melting points, and upon a universal vapor pressure curve applicable to all substances.

REFRIGERATION

Ice Making

Modern Raw Water Ice Making Plant. Ice & Refrigeration, vol. 55, no. 1, July 1, 1918, pp. 1-6, 9 figs. Details of motor-driven 100-ton plant with complete equipment.

Multiple-Effect Compression

Multiple-Effect Compression Ice-Making and Refrigerating Machines. Engineering, vol. 106, no. 2747, Aug. 23, 1918, pp. 201, 7 figs. Diagram showing working cycle, indicator cards, and general description of a CO_2 multiple-effect compression refrigerating machine built by Seagers, Ltd., Dartford, Kent.

Storage-Room Refrigeration

Efficiency in Engineeering, Eric H. Peterson. Ice & Refrigeration, vol. 55, no. 1, July 1, 1918, pp. 9-11, 5 figs. Charts showing refrigeration required for various temperatures in well-ventilated rooms and amount of pipe required for storage rooms.

ROADS AND PAVEMENTS

Concrete Roads

A Road Finisher That Produces Denser Concrete. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, p. 33, 1 fig. Device designed in 1913 by E. G. Carr, said to eliminate voids in concrete, and to have been used in construction of 400 miles of California's highways.

Pavement Planer Method of Finishing Concrete Roads, E. Earl Glass. Eng. & Contracting, vol. 50, no. 14, Oct. 2, 1918, pp. 318-319, 4 figs. Description of tools and methods used in making a concrete road in California.

Corners

Width of Roadway and Corner Cut-Off, R. H. Whitten. Mun. Jl., vol. 45, no. 9, Aug. 31, 1918, pp. 166-167, 3 figs. Plans made by City Plan Commission of Cleveland for increasing corner radii and angle of vision.

Earth Roads

Method of Handling Materials for Concrete Roads. Eng. & Cement World, vol. 13, no. 7, Oct. 1, 1918, p. 31, 2 figs. Advantages of eliminating stock piles along route.

The Location, Construction and Maintenance of Earth Roads, H. R. MacKenzie. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 181-186. Emphasizes engineering supervision of construction and constant attention to maintenance as principal factors necessary to make of an earth road a satisfactory highway.

Furnace-Slag Sub-Crust

Roads During and After the War, E. Purnell Hooley. Surveyor, vol. 54, no. 1385, Aug. 2, 1918, pp. 59-60. Use of furnace slag as sub-crust in macadam and telford roads. Paper before Instn. Mun. and County Engrs.

Highways

State-Aid Highway Work in Illinois, C. M. Hathaway. Am. City, vol. 19, no. 3, Sept. 1918, pp. 176-182, 3 figs. Widths, drainage, alignment and design of state-aid roads; discussion of construction materials—concrete, brick, bituminous, macadam and oiled earth; state-aid bridge work; grade-crossing problems. (Concluded.)

The Planning of a System of Rural Highways Under Conditions Existing in Province of Saskatchewan, W. M. Stewart. Jl. Eng. Inst. of Can., vol. 1, no. 5, Sept. 1918, pp. 189-192 and (discussion) 192-193. Classification of roads and determination of satisfactory type of surface to be used on a certain road from an estimate of volume and class of traffic to be provided for. Also published in Can. Engr., vol. 35, no. 10, Sept. 5, 1918, pp. 217-218.

Typical Specifications for Non-Bituminous Road Materials, Prevost Hubbard and Frank H. Jackson. U. S. Department of Agriculture, Bul. no. 704, professional paper, Aug. 30, 1918, 38 pp., 3 figs. For 19 common materials used in the construction and maintenance of various types of highways; descriptions of methods of testing to which reference is made in specifications.

Wood-Block Pavements

Proper Method of Application of Bituminous Filler for Creosoted Wood Block Pavements and Floors, Lambert T. Ericson. Eng. & Contracting, vol. 50, no. 14, Oct. 2, 1918, pp. 320-321, 2 figs. To prevent an excess of tar on pavement in hot weather, joints should be filled with tar or other substance at very high temperature so that joint will be well penetrated; details of proper application given.

SAFETY ENGINEERING

Acetylene, Dissolved, Cylinders for

Report of the Departmental Committee on Cylinders for Dissolved Acetylene (VI). Acetylene & Welding Jl., vol. 15, no. 179, Aug. 1918, pp. 146-150, 2 figs. Report on two samples of charcoal and on alternating pressure tests made on two dissolved acetylene cylinders. (Concluded.)

Blow-Off Tanks

Explosion of a Blow-off Tank. Travelers Standard, vol. 6, no. 9, Sept. 1918, pp. 177-181, 3 figs. Suggestions on construction and installation of blow-off tanks derived from an account of a recent explosion at a Cleveland manufacturing plant.

Construction Work

Benefit of Accident Prevention in Contracting, F. S. Robinson. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 311-312. Abstract of paper before Construction Section of National Safety Council, Sept. 1918.

Safety Engineering and Accident Prevention in Construction Work, Leo D. Woedtke. Eng. & Contracting, vol. 50, no. 13, Sept. 25, 1918, pp. 299-303. Accident prevention methods of Fred T. Ley & Co., Inc. Abstract from address before Construction Section Meeting of National Safety Council, Sept. 1918.

Dust Inhalation

Effects of Mine-Dust Inhalation, J. S. Haldane. Eng. & Min. Jl., vol. 106, no. 11, Sept. 14, 1918, pp. 475-477. Effects of various kinds of dusts when breathed by mine or mill workers. From paper submitted to Chem. Metallurgical & Min. Soc. of South Africa, and Instn. of Min. Engrs., London. Published also in Trans. Instn. Min. Engrs., vol. 55, part 4, Aug.-Sept. 1918, pp. 264-273 and (discussion) pp. 273-293.

A Short List of References on the Dust Hazard in Industry. Library of the National Workmen's Compensation Service Bureau, Reference List No. 3. A short bibliography.

Dust Explosions

Considerations Respecting Causes of Dust Explosions (Einiges über Staubexplosionem), G. Bauer. Zeitschrift für angewandte Chemie, year 30, no. 79, Oct. 2, 1917, pp. 239-240, 4 figs.

Explosives

Safety in the Use of Explosives, Arthur La Motte. Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 490-496. Paper before Nat. Safety Council.

Fire Hazards

The Factory Fire Brigade (I), Paul Mason. Am. Indus., vol. 19, no. 2, Sept. 1918, pp. 14-16. Organization, equipment and discipline.

First Aid

Elementary First Aid for the Miner, W. A. Lynott and D. Harrington. Sci. & Art of Min., vol. 29, no. 2, Aug. 24, 1918, pp. 22-23. What to do at once when a fellow miner is hurt; general directions for caring for bleeding; miscellaneous precautions; dressing for broken bones; electric shock. From Miner's Circular 23, U. S. Bureau of Mines.

Flying Objects

Injury from Flying Objects, Chesla C. Sherlock. Am. Mach., vol. 49, no. 14, Oct. 3, 1918, pp. 625-627. Legal aspects of injuries received from flying objects discussed.

Headlights, Automobile

Automobile Headlights and Glare Reducing Devices, L. C. Porter. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 627-632, 13 figs. General discussion showing set of curves indicating candlepower necessary to "pick up" a man at various distances.

Dazzling Head Lamps. Autocar, vol. 41, no. 1192, Aug. 24, 1918, p. 188. Tests and standard specifications adopted in New York State.

Lightning Arresters

The Oxide Film Lightning Arrester, Crosby Field. Gen. Elec. Rev., vol. 21, no. 9, Sept. 1918, pp. 597-601, 6 figs. Principle, construction and operation of instrument which consists essentially of an insulating film placed between a conductor and lead peroxide.

Machinery Movements

Abnormal Movement of Machinery, Chesla C. Sherlock. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 578-580. Discussion of accidents due to a sudden and abnormal movement of machinery, taking operator by surprise, and legal aspects.

Mine Accidents

Who Gets Hurt and Why. Coal Age, vol. 14, no. 11, Sept. 12, 1918, pp. 480-482, 7 figs. Details relating to total distribution of mine accidents, from records of Ellsworth Collieries.

Quarrying

Safe Practices in the Quarry and Mill, William H. Baker. Eng. & Cement World, vol. 13, no. 4, Aug. 15, 1918, pp. 53-54. Precautions taken at Hannibal, Mo., mills of Atlas Portland Cement Co. Abstract of paper before Nat. Safety Council.

Railroad Administration, Safety Work

Safety Program of Railroad Administration, Hiram W. Belnap. Ry. Rev., vol. 63, no. 12, Sept. 21, 1918, pp. 426-428. What it expects of different organizations in promotion of safety work. Abstract from paper before Nat. Safety Council, St. Louis.

Scaffolds

Safe Construction of Scaffolds and Falsework, T. F. Foltz. Eng. & Contracting, vol. 50, no. 12, Sept. 18, 1918, pp. 285-288. Abstract of paper before National Safety Council.

Small Shops

How Accident Prevention Work May Be Carried On in Small Companies, Wills Machlachlan. Am. Gas Eng. Jl., vol. 109, no. 14, Oct. 5, 1918, pp. 319-322. Suggestions in regard to equipment and organization. Paper before National Safety Congress.

Winding Engines

Safety in Winding Operations, J. A. Vaughan. South African Mining Jl., vol. 27, part 2, no. 1399, July 20, 1918, pp. 269-270. Remarks on safe handling of winding engine based on author's experience and compiled statistics of winding accidents in the Witwatersrand. Paper before the S. A. A. A. S.

See also Electrical Engineering (Excessive Voltages), (Safety Measures); Hoisting and Conveying (Safety Appliances), (Wire Ropes); Military Engineering (Mine Safety Appliances); Roads and Pavements (Corners).

SANITARY ENGINEERING

Plumbing

The Why and Wherefore of Sanitary Engineering, Arthur Bateman. Domestic Eng., vol. 84, no. 9, Aug. 31, 1918, pp. 315-317 and 344, 7 figs. Technical and scientific plumbing and sanitation. (Continuation of serial, preceding installment appeared July 13.)

Sewage Disposal

Sewage Disposal, Edward Willcox. Surveyor, vol. 54, no. 1385, Aug. 2, 1918, pp. 55-56. Camp sewage disposal; fertilizers from sewage; design of plants; Wolverhampton experiments; American research work. Assn. Mgrs. Sewage Disposal. (To be concluded.) Published also in Can. Engr., vol. 35, no. 10, Sept. 5, 1918, pp. 224-225.

Water Supply

Experience with Artesian Water Supply in Savannah, E. R. Conant. Am. City, vol. 19, no. 3, Sept. 1918, pp. 182-192, 1 fig. From paper before Am. Water Works Assn.

STANDARDS AND STANDARDIZATION

Gas-Meter Threads

Standardization of Gas Meter Threads and Connections in Germany (Die Vereinheitlichung der Gasmesser-Verschraubungen und

Verbindungen), D. Elsele. Journal für Gasbeleuchtung, year 61, no. 16, Apr. 20, 1918, pp. 181-183, 2 figs.

Pyrometers

Pyrometer Standardization, Ezer Griffiths and F. H. Schofield. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 222-237, 6 figs. Indicates temperature-scale basis of practical types and errors to which pyrometric observations are liable.

Screw Thread

The Relation of Screw-Thread Angles to Other Functions, H. J. Bingham Powell. Am. Mach., vol. 49, no. 13, Sept. 26, 1918, pp. 571-573, 1 fig. Author sets forth his reasons for advocating adoption as an international standard the Whitworth thread.

Tubes, Seamless

International Aircraft Standards. Flight, vol. 10, no. 33, Aug. 15, 1918, p. 919. Specifications for alloy-steel seamless tubes of 200,000 lb. per sq. in. tensile strength. (Continued.)

See also Cement and Concrete (Portland Cement); Engineering Materials (Asphalt); Marine Engineering (Fabricated Ships), (Standard Vessels); Railroad Engineering, Steam (Locomotives, Standard).

STEAM ENGINEERING

Boiler Gage Glass

The Boiler Gage Glass, Wm. L. De Baufre. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 547-556, 2 figs. Explains how to determine actual weight of water contained in boiler, and gives corrections to be applied in tests where the gage-glass reading, the steam pressure and the rate of steaming at the end of a run are different from those obtaining at the beginning.

Boilers

Examination of Steam Boilers at Collieries, Edward Ingham. Colliery Guardian, vol. 116, no. 3007, Aug. 16, 1918, pp. 336-337, 9 figs. Typical defects found in inspection of boilers explained.

Steam-Boiler Regulation and Control, Albert A. Straub. Power, vol. 48, no. 13, Sept. 24, 1918, pp. 442-446, 6 figs. Brings out point that proper handling of damper for controlling draft for steam-boiler furnaces is of importance, and presents charts showing variation of temperature of escaping gases and of steam pressure.

Pressure Losses

Pressure Losses in Steam Plants, R. S. Hawley. Power Plant Eng., vol. 22, no. 18, Sept. 15, 1918, pp. 739-741, 2 figs. Causes; distinction between losses due to throttling and radiation.

Scale, Boiler-Tube

Boiler-Tube Scale; Its Removal with Kerosene as Practised at the Fuel-Oil Testing Plant, Albert M. Penn. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 512-517, 2 figs. 15 gal. of kerosene were poured into each lower drum with tin funnel, 100-lb. steam allowed to flow in and condense until water glass was three-quarters full. Photographs showing results and precautions advised.

Soot Removal

Soot Removal from Fire-Tube Boilers. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 305-308, 13 figs. Rear-end and front-end blowers for return tubular boilers, rocking elements for internally fired boilers and gear-turned blowers for vertical boilers.

Steam, High-Pressure

Advantages of High Pressure and Superheat as Affecting Steam Plant Efficiency, Eskil Berg. Elec. Rev., vol. 73, no. 12, Sept. 21, 1918, pp. 444-447, 3 figs. Possibilities of higher steam pressures and temperatures for reducing mechanical and thermal losses in turbines.

The Uses of High-Pressure and High-Temperature Steam in Large Power Stations, J. H. Shaw. Contract Rec., vol. 32, no. 35, Aug. 28, 1918, pp. 703-705. Comparison of costs illustrated by schedule showing coal, steam and heat consumption for a 20,000-kw. machine running at 200 lb. and 350 lb. gage pressure at varying superheats and also at 500 lb. pressure absolute and 268 deg. fahr. superheat. Paper before Instn. Civ. Engrs. Also published in Elec. News, vol. 27, no. 17, Sept. 1, 1918, pp. 29-31, and in Elecn., vol. 81, no. 2100, Aug. 16, 1918, pp. 330-332, 5 figs.

Superheaters

General Construction and Maintenance of Superheater Units. Ry. & Locomotive Eng., vol. 31, no. 10, Oct. 1918, pp. 315-316, 4 figs. Device especially designed to prevent leakage in the joints and rapid deterioration of the ends of superheater pipes.

The Value of Superheated Steam at the Colliery and at Iron Works. Iron & Coal Trades Rev., vol. 97, no. 2635, Aug. 30, 1918, pp. 238-239, 2 figs. Description of Sugden superheater, with Stirling boiler and independently fired.

Turbines

A 35,000-kw. Turbine is Wrecked in Northwest Station, Chicago. Power, vol. 48, no. 10, Sept. 3, 1918, pp. 345-348, 4 figs. Detailed description of accident to 35,000-kw. turbine at Northwest Station, Chicago. Failure of nineteenth wheel probable cause of wreck.

Additional Power at Small Cost by Exhaust Steam Turbine. Can. Machy., vol. 20, no. 11, Sept. 12, 1918, pp. 317-318, 3 figs. Saving of fuel and boiler capacity obtained in paper mill by connecting steam turbines to line shaft through reduction gear.

The Forty-five Thousand Kilowatt Compound Turbine at Providence, R. I., J. P. Rigsby. Power, vol. 48, no. 9, Aug. 27, 1918, pp. 292-298, 9 figs. Illustrated description of 45,000-kw. cross-compound reaction Westinghouse turbine at Providence, R. I.

Valves, Safety

Graphic Methods of Determining Size of Safety Valve, H. F. Gauss. Power, vol. 48, no. 12, Sept. 17, 1918, pp. 414-417, 4 figs. Reasons for increasing maximum allowable lifts above those permitted in the A.S.M.E. Code. Napier's formula for the flow of steam through an orifice used as a basis for constructing capacity curves. General solution by means of logarithmic charts.

Safety and Relief Valves, M. W. Rink. Jl. Am. Soc. Naval Engrs., vol. 30, no. 3, Aug. 1918, pp. 504-511, 7 figs. Construction and use of shifting and cylinder relief valves for a mixture of steam and water. From Marine Eng.

See also Engineering Materials (Boiler Plates); Power Generation and Selection (Exhaust Steam).

STEEL AND IRON

By-Products

By-Product Recovery in Iron and Steel Works. Engineering, vol. 106, no. 2747, pp. 206-207. Utilization of gas and other by-products of iron and steel works. From paper by A. Gouvy before Congrès du Génie Civil, Paris, March 1918.

Blast Furnaces

Fuel Economy in Blast Furnaces, T. C. Hutchinson. Iron Age, vol. 102, no. 12, Sept. 19, 1918, pp. 689-691, 3 figs. Cleaning the ore and size of bell factors in larger output and lower coke consumption in British practice; long life of furnace walls. From paper before Iron & Steel Inst., London, May 1918.

Casting

Sound Steel by Lateral Compression, Benjamin Talbot. Iron Age, vol. 102, no. 14, Oct. 3, 1918, pp. 836-838, 2 figs. British results from applying this principle to tap portion of slag; cheap refractory top of slag. From paper before Iron & Steel Inst., London, May 1918.

Corrosion

Corrosion of Iron and Steel, and its Prevention (VII), Abe Winters. Can. Machy., vol. 20, no. 9, Aug. 29, 1918, pp. 257-258. Considerations on sherardizing process (covering heated iron with zinc dust) with reference to temperature and time, and its commercial application.

Electric Steel

Electric Steel Making, Arthur V. Farr. Machy., vol. 25, no. 1, Sept. 1918, pp. 40-42, 9 figs. Importance and growth of electric-steel industry; cold-melt process and structure of electric steel.

The Electric Furnace in the Steel Casting Industry, W. E. Moore. Elec. Jl., vol. 15, no. 9, Sept. 1918, pp. 331-332. Remarks on advantages and disadvantages of various processes of manufacturing steel—crucible melting, open-hearth, side-blow converter, and the electric furnace.

The New Electric Steel Plant at Toronto (La nouvelle aciérie électrique de Toronto). Génie Civil, vol. 72, no. 26, June 29, 1918, pp. 479-481, 3 figs. Plans, views and description.

Ferro-Alloys

The Manufacture of Ferro-Alloys in the Electric Furnace, R. M. Keeney. Min. Jl., vol. 122, no. 4334, Sept. 14, 1918, pp. 538-539. Ferrouranium. Paper before Am. Inst. Min. Engrs. (Continuation of serial.)

Iron, Molecular Instability

Molecular Instability Due to Magnetostriction (Instabilité moléculaire par le magnétostriction), D. Hurmuzescu. Revue Générale de l'Electricité, vol. 4, no. 7, Aug. 17, 1918, pp. 211-214, 1 fig. Results of experimental study which led author to assert that, unlike steel, iron under certain conditions possesses molecular instability.

Iron-Titanium Ores

On the Microstructure of Certain Titanium Iron Ores, Chas. H. Warren. Economic Geology, vol. 13, no. 6, Sept. 1918, pp. 419-446, 12 figs. Experimental study of titanium-iron-oxide minerals, including a number of ilmenites from different parts, carried out on large Leitz metallographic microscope, using a small 4-ampere arc as source of light.

Ore Resources

Notes on Certain Iron-Ore Resources of the World, C. E. Harder, W. Lindgren, C. M. Weld, A. C. Spencer, H. F. Bain, and Sidney Paige. Bul. Am. Inst. Min. Engrs., no. 141, Sept. 1918, pp. 1471-1496. Brazil, Scandinavia, Cuba, Southern Europe, China, and Alsace-Lorraine.

Application of Optical Pyrometry in Steel Works Practice, J. N. Greenwood. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 295-308, 4 figs. Comparison of various conditions of use of an optical pyrometer in taking temperatures of liquid steel in the open with calibration conditions; errors due to emissivity; polarization of emitted light, and lack of monochromatism; technical defects of the Cambridge type; suggestion to obtain control of steel-making process pyrometrically.

Pyrometry

Notes on Pyrometry from the Standpoint of Ferrous Metallurgy, W. H. Hatfield. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 289-294. Account of methods to control temperature used in large armament works.

Temperature Determinations of Liquid Steel, A. McCance. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 309-310. Work done at the Parkhead Steel Works to develop a system of controlling the temperature in an open-hearth furnace by an optical pyrometer.

The Determination of the Temperature of Liquid Steel Under Industrial Conditions, Cosmo Johns. Trans. Faraday Soc., vol. 13, part 3, June 1918, pp. 280-288. Account of author's experience; suggestion to adopt as standard an optical pyrometer using monochromatic light $\lambda = 0.65\ \mu$.

Semi-Steel

Steel Mixture Iron—The Use of Scrap Steel in Pig Iron Mixtures. Contract Rec., vol. 32, no. 37, Sept. 11, 1918, pp. 731-732. Factors involved in absorption of carbon from coke by steel during cupola melting and experiment illustrating this absorption; results obtained from melting steel borings and crop ends from smithy in a cupola together with 10 per cent ferrosilicon. From the Engineer, London.

Steel, Hardness and Tensile Strength

Tensile Strength and Hardness of Steel, H. M. Brayton. Iron Age, vol. 102, no. 11, Sept. 12, 1918, pp. 627-629, 3 figs. Their relation shown by means of graphical charts which give either variable in terms of the other.

Steel Mills

Fuel Economy in a Modern Steel Works, Benjamin Talbot. Colliery Guardian, vol. 116, no. 3010, Sept. 6, 1918, pp. 493-494. Examination of most economical fuel consumption possible to obtain in practice in a modern steel works. Appendix II to Carbonization Committee's Report, Board of Trade. Also published in Iron & Coal Trades Rev., vol. 97, no. 2634, Aug. 23, 1918, pp. 210.

Mechanical and Electrical Equipment of a Southern Steel Mill. Southern Engr., vol. 30, no. 2, Oct. 1918, pp. 36-43, 12 figs. Waste-heat boiler installation, mixed-pressure turbines, motor drive for billet mills, roughing mills and other machinery, motor control.

Tubes, Seamless

Tubes and Tubular Structures, W. W. Hackett and A. G. Hackett. Aviation, vol. 5, no. 4, Sept. 15, 1918, pp. 230-234. Review of method of manufacturing seamless steel tubing, of difficulties to be overcome, and forms of manipulation which it is possible to put upon good quality steel tubing; account of tests carried out on specimen tubes, under various conditions, and joined together in different ways. Paper before Aeronautical Soc. of Great Britain.